WORK PLAN

FOR WATERSHED PROTECTION AND FLOOD PREVENTION

MILL CREEK WATERSHED

Hendricks, Morgan, Owen and
Putnam Counties, Indiana

OUR SOIL ★ OUR STRENGTH

USDA-SCS-LINCOLN, NEBR. 1965


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Agriculture
National Agricultural Library

WATERSHED WORK PLAN
MILL CREEK WATERSHED
HENDRICKS, MORGAN, OWEN AND PUTNAM COUNTIES, INDIANA

Prepared Under the Authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress, 68 Stat. 666) as Amended

Prepared By:
HENDRICKS COUNTY SOIL AND WATER CONSERVATION DISTRICT
MORGAN COUNTY SOIL AND WATER CONSERVATION DISTRICT
OWEN COUNTY SOIL AND WATER CONSERVATION DISTRICT
PUTNAM COUNTY SOIL AND WATER CONSERVATION DISTRICT

Assisted By:
U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE
U. S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE
INDIANA DEPARTMENT OF NATURAL RESOURCES

April 1965

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WATERSHED WORK PLAN AGREEMENT

Between the

Hendricks County Soil and Water Conservation District, Morgan County Soil and Water Conservation District, Owen County Soil and Water Conservation District, and Putnam County Soil and Water Conservation District (hereinafter referred to as the Sponsoring Local Organization),

State of Indiana

and the

Soil Conservation Service
United States Department of Agriculture
(hereinafter referred to as the Service)

WHEREAS, application has heretofore been made to the Secretary of Agriculture by the Sponsoring Local Organization for assistance in preparing a plan for works of improvement for the Mill Creek Watershed, State of Indiana, under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress; 68 Stat. 666) as amended; and

WHEREAS, the responsibility for administration of the Watershed Protection and Flood Prevention Act, as amended, has been assigned by the Secretary of Agriculture to the Service; and

WHEREAS, there has been developed through the cooperative efforts of the Sponsoring Local Organization and the Service a mutually satisfactory plan for works of improvement for the Mill Creek Watershed, State of Indiana, hereinafter referred to as the Watershed Work Plan, which is annexed to and made a part of this agreement;

NOW, therefore, in view of the foregoing considerations the Sponsoring Local Organization and the Secretary of Agriculture, through the Service, hereby agree on the watershed work plan, and further agree, that the works of improvement as set forth in said Plan can be installed in about eight (8) years.

It is mutually agreed that in installing and operating and maintaining the works of improvement substantially in accordance with the terms, condition, and stipulations provided for in the watershed work plan:

1. The Sponsoring Local Organization will acquire such land, easements and/or rights-of-way as will be needed in connection with the works of improvement. (Estimated cost $894,000.) The percentages of this cost to be borne by the Sponsoring Local Organization and the Service are as follows:

Works of Improvement	Sponsoring Local Organization (percent)	Service (percent)	Estimated Cost (dollars)
Multipurpose Structure No. 9 and Basic Recreational Facilities - Payments to landowners for the purchase of 659 acres and cost of relocation or modification of improvements	70.0	30.0	$194,700
Flowage Easements	100.0	0	1,400
Land Acquisition Costs	100.0	0	4,000
All other Structural Measures	100.0	0	693,900

2. The Sponsoring Local Organization will acquire or provide assurance that landowners or water users have acquired such water rights pursuant to State Law as may be needed in the installation and operation of works of improvement.

3. The percentages of construction costs of structural measures to be paid by the Sponsoring Local Organization and by the Service are as follows:

Works of Improvement	Sponsoring Local Organization (percent)	Service (percent)	Estimated Cost (dollars)
Multiple Purpose Structure No. 9	28.65	71.35	123,970
Basic Recreational Facilities No. 9	50.00	50.00	65,000
Multiple Purpose Structure No. 3	23.50	76.50	95,800
All Other Structural Measures	0	100.00	2,712,400

4. The percentages of the cost for installation services to be borne by the Sponsoring Local Organization and the Service are as follows:

Works of Improvement	Sponsoring Local Organization (percent)	Service (percent)	Estimated Cost (dollars)
Multiple Purpose Structure No. 9	0	100.0	47,110
Basic Recreational Facilities No. 9	100.0	0	7,500
Multiple Purpose Structure No. 3	23.5	76.5	36,500
All Other Structural Measures	0	100.0	933,300

5. The Sponsoring Local Organization will bear the cost of administering contracts. (Estimated cost $34,300.)

6. The Sponsoring Local Organization will obtain agreements to carry out conservation farm plans on their lands from owners of: 1) not less than 50% of the land above each floodwater retarding structure prior to construction and 2) 75% of the total agricultural land in the watershed by the time the project is completed.

7. The Sponsoring Local Organization will provide assistance to landowners and operators to assure the installation of the land treatment measures shown in the watershed work plan.

8. The Sponsoring Local Organization will encourage landowners and operators to operate and maintain the land treatment measures for the protection and improvement of the watershed.

9. The Sponsoring Local Organization will be responsible for the operation and maintenance of the structural works of improvement by actually performing the work or arranging for such work in accordance with agreements to be entered into prior to issuing invitations to bid for construction work.

10. The cost shown in this agreement represents preliminary estimates. In finally determining the costs to be borne by the parties hereto, the actual costs incurred in the installation of works of improvement will be used.

11. This agreement does not constitute a financial document to serve as a basis for the obligation of Federal funds, and financial and other assistance to be furnished by the Service in carrying out the watershed work plan is contingent on the appropriation of funds for this purpose. Where there is a federal contribution to the construction cost of works of improvement, a separate agreement in connection with each construction contract will be entered into between the Service and the Sponsoring Local Organization prior to the issuance of the invitation to bid. Such agreement will set forth in detail the financial and working arrangements and other conditions that are applicable to the specific works of improvement.

12. The watershed work plan may be amended or revised, and this agreement may be modified or terminated, only by mutual agreement of the parties thereto.

13. No member of or delegate to Congress, or resident commissioner shall be admitted to any share or part of this agreement, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this agreement if made with a corporation for its general benefit.

14. The Sponsoring Local Organization agrees that all land on which Federal assistance is provided will not be sold or otherwise disposed of for the evaluated life of the project, except to a public agency which will continue to maintain and operate the recreational development in accordance with the operations and maintenance agreement.

15. The program conducted will be in compliance with all requirements respecting nondiscrimination as contained in the Civil Rights Act of 1964 and the regulations of the Secretary of Agriculture (7 C.F.R.. Sec. 15.1-15.13) which provide that no person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any activity receiving Federal assistance.

HENDRICKS COUNTY SOIL AND WATER CONSERVATION DISTRICT

BY _____

TITLE _____

Date _____

The signing of this agreement was authorized by a resolution of the governing body of the Hendricks County Soil and Water Conservation District,

adopted at a meeting held on _____.

_____

(Secretary, Hendricks County Soil and Water Conservation District)

Date _____

MORGAN COUNTY SOIL AND WATER CONSERVATION DISTRICT

BY _____

TITLE _____

Date _____

The signing of this agreement was authorized by a resolution of the governing body of the Morgan County Soil and Water Conservation District,

adopted at a meeting held on _____.

_____

(Secretary, Morgan County Soil and Water Conservation District)

Date _____

OWEN COUNTY SOIL AND WATER CONSERVATION DISTRICT

BY _____

TITLE _____

Date _____

The signing of this agreement was authorized by a resolution of the governing body of the Owen County Soil and Water Conservation District,

adopted at a meeting held on _____.

_____

(Secretary, Owen County Soil and Water Conservation District)

Date _____

PUTNAM COUNTY SOIL AND WATER CONSERVATION DISTRICT

BY _____

TITLE _____

Date _____

The signing of this agreement was authorized by a resolution of the governing body of the Putnam County Soil and Water Conservation District,

adopted at a meeting held on _____.

_____

(Secretary, Putnam County Soil and Water Conservation District)

Date _____

SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE

BY _____

(Administrator)

Date _____

SUMMARY OF THE PLAN

The Mill Creek Watershed is located in west central Indiana and the drainage area includes parts of Putnam, Hendricks, Morgan and Owen Counties. In area it covers about 187,136 acres or 292.4 square miles. In this total there are 7,300 acres of Federal land and 650 acres of State owned land. Mill Creek rises about 20 miles west of Indianapolis and flows south and southwest until it outlets into Cagles Mill Reservoir, and then into the Eel River.

This work plan was developed by the Putnam, Hendricks, Morgan and Owen County Soil and Water Conservation Districts as Sponsors of the application. The Mill Creek Conservancy District, now being organized, will become a Sponsor. Technical assistance was provided by the U. S. Department of Agriculture through the Soil Conservation Service and the Forest Service, and by the Indiana Department of Natural Resources.

The principal problems in the watershed are damages from frequent flooding which occurs more often than once a year and keeps the valuable farmland covered with water from one to four days. The area inundated by the 50-year frequency storm is approximately 18,600 acres of which 14,366 acres are cropland. The present channels serve as a satisfactory drainage outlet in periods when there are no flood flows or minor channel stages. Bank full flow creates a condition in which drainage channels and tile that outlet in Mill Creek, or its major tributaries, can not function properly. A land treatment program co-ordinated with the structural measures included in this plan is the most feasible method of overcoming the problem.

The land treatment measures are to be installed by individual landowners or operators. Included are the needed conservation measures having hydrologic, erosion, and sediment control significance in reducing floodwater damage, and those which contribute to achieving agricultural water management benefits. The local cost of land treatment measures to be installed on the farms of Soil and Water Conservation District cooperators is estimated to be $1,275,966 which includes $33,900 for forestry measures. The total estimated funds for technical assistance that will be available amount to: $221,415 from the present Soil and Water Conservation Districts' program, $457,781 from PL-566 funds, and $18,690 from the Indiana Department of Natural Resources, Division of Forestry.

The structural measures designed for inclusion in the work plan include: Twelve single purpose floodwater retarding structures, two multi-purpose floodwater retarding and recreation structures, and 53.3 miles of single purpose flood prevention channel improvement.

Structure No. 9 will be a public recreational development with assistance from PL-566, State, and local funds for installation of the lake and the recreation facilities.

The level of protection provided by the combination of land treatment and structural measures is 3-years for the cropping season. This will provide a reduction in flood hazard to 18,600 acres of which 14,366 acres are cropland. It is estimated that cropland in the benefited area will remain the same with project as under present conditions; the acres going out of cropland in flood pools, etc. will equal land going into cropland use. The benefits provided are due to elimination of damages due to flooding which will allow for more consistent and practical management in addition to reduction in road and bridge costs and recreational benefits.

The installation period is planned for a total of eight years and the total installation cost is estimated at $6,923,732 of which $2,492,561 is non-federal.

Total installation cost of the structural measures is $4,949,880 of which $3,973,390 is PL-566 cost and $976,490 is non-federal.

The total project cost including land treatment measures is $6,923,732 of which $4,431,171 is PL-566 cost and $2,492,561 is non-federal. Also the non-federal cost for land treatment applied to date is $1,966,053.

The estimated annual operation and maintenance cost is $49,284 and will be borne by the Mill Creek Conservancy District.

The ratio of average annual benefits of $388,035 to the average annual cost of $246,240 is 1.6 to 1.0.

DESCRIPTION OF THE WATERSHED

Physical Data

The Mill Creek Watershed lies in four west central Indiana Counties; Hendricks, 61,000 acres; Morgan, 43,000 acres; Owen, 30,200 acres; and Putnam, 52,936 acres; with a total area of 187,136 acres or 292.4 square miles. There are 7,300 acres of Federal owned land and 650 acres of State owned land in the watershed. Mill Creek rises in west central Hendricks County about three miles west of Danville, Indiana. The direction of stream flow is generally south for about sixteen miles, then southwest for about fifteen miles to Upper Cataract Falls, which is the upper flood pool limits of Cagles Mill Reservoir, a U. S. Corps of Engineer facility. From Cagles Mill Dam, the lower limit of the watershed project, Mill Creek empties into Eel River to the northwest. The major tributaries of Mill Creek are: East Fork of Mill Creek, Mud Creek, Lake Ditch, Rhodes Creek, and Brush Creek on the east side; and Crittenden Creek, Cotton Branch, Vermillion Branch, Sallust Branch, Higgins Branch and Sand Branch on the west side.

Cagles Mill Reservoir, with a minimum pool surface area of 1400 acres, and all land draining into the lake, composes the Mill Creek Watershed. The minimum pool of the reservoir extends to the Lower Cataract Falls. The maximum flood pool covers approximately 4,840 acres.

The watershed topography varies considerably from the upper to lower reaches. The upper reaches along Mill Creek and East Fork, and along the middle west side of the watershed are fairly flat to gently rolling uplands. The ridges are wide and almost completely cropped, while the stream valleys are relatively narrow with some cropland, but mostly pasture. The areas along middle Mill Creek valley, Mud Ditch, and Lake Ditch are wide and flat with no bluffs or abrupt slopes. The long, adjacent upland slopes merge so gradually with the lowlands that no definite boundary between them can be established. The Mud and Lake Ditch areas are wide depressions which had poor natural drainage until the present channels were constructed. Since then the main channels have provided outlets for the numerous laterals and tile mains that have been constructed. The middle and upper reaches are located in the Tipton Till physiographic region, the topography of which was influenced mostly by the Wisconsin glaciation.

In the lower reaches south of Indiana Highway 42 and west of Indiana Highway 43, the topography is influenced by Illinois and Wisconsin glaciation, as well as local bedrock conditions. The uplands are steep to rolling with many trees along the stream channels and around

Cagles Mill Reservoir. Bedrock influence is evident from numerous sink holes south of the Cataract area, and rock (limestone) ledges and falls are located along Mill Creek at Upper and Lower Cataract Falls and upstream nearly to Highway 43. This area is known as the Mitchell Plain physiographic region.

Depth to bedrock varies from surface exposures to 150 feet. Mean sea level elevation varies from 636 to 1000, with local difference in the flat areas of 10 to 50 feet.

The soils are derived to some extent from glacial deposits, but also from a loess cap two to three feet thick over most of the area. Some outwash and terrace soils are found along the major streams. The major upland soils are: Well drained Russell, Cincinnati, and Fox (kame phase); moderately well drained Gibson; imperfectly drained Fincastle and Vigo: and very poorly drained Brookston. The Fox series is the major terrace soil. The bottomland is represented by the Genesee, Eel, and Shoals series.

A high percentage of the watershed area is cropland. This cropland has fair to poor hydrologic cover. A more intensive application of conservation measures will greatly increase water infiltration and reduce upland soil loss.

The average annual rainfall is 41.25 inches with the months of May and June having the highest average accumulation. The seasonal distribution is as follows: Spring, 11.64 inches; summer, 11.66 inches; autumn, 9.86 inches; and winter, 8.09 inches. The average annual snowfall is about 23 inches, of which 16.5 inches fall during the winter months, December through February. The average growing season is about 170 days, with the last damaging frost occurring in April and the first in October. The mean temperature for July is 76°F and 31°F for January, with extremes to 105°F and -21°F, respectively. The climate is generally continental (humid and temperate). Summers are warm and humid with high intensity, short duration rainfall, and winters are moderately severe with frequent temperature changes.

Economic Data

The agricultural income derived from the sale of agricultural products is as follows: Crops 35%, livestock (not including dairy and poultry) 54%, dairy 7%, poultry 4%. The class of farms by percentages are: Livestock 30%, general 47%, cash grain 17%, dairy 5%, poultry 1%. The value of the land with improvement in the watershed is as follows: The value per acres is $265; the value per farm is $55,094. There are 1,207 farms within the watershed averaging 149 acres.

U. S. Highway 40 extends through the watershed for a distance of 14 miles, State Highways for 55 miles and one proposed Interstate Highway (I-70). There are numerous pipe lines throughout the watershed.

The trade area for the watershed consists of Greencastle, Danville, and Indianapolis which are outside the watershed. The small towns in the watershed, all of which have less than 500 population, are Hadley, Amo, Coatsville, Clayton, Stilesville, Belle Union, Crown Center, Little Point, Hazelwood, Eminence, Quincy, Cloverdale and Cataract.

The average land use on privately owned land in the watershed with and without project is as follows:

LAND USE	PRESENT	FUTURE	
		Without Project 1/	With Project
Cropland	108,983	114,754	114,754
Grassland	32,205	27,436	27,436
Woodland	19,700	20,500	20,500
Idle & Misc.	18,298	16,496	16,496
TOTAL	179,186	179,186	179,186

1/ Based on Conservation Needs Inventory.

Fish and Wildlife

Most of the upper portion of Mill Creek and its major tributaries have been extensively straightened and dredged. These changes destroyed the desirable pool-riffle and meandering characteristics of the stream, creating a highly unsuitable habitat for most sport fish. It appears that only about 10.5 miles or less of stream can be utilized as a sport fishery after renovation. This favorable stream section is located in the lower reaches of the main channel. This section has numerous natural holes in limestone rock from about Indiana Highway 43 downstream to the Upper Cataract Falls.

More than 55 percent of the fish found during sampling consisted of six desirable species, which are: Longear sunfish, spotted bass, small mouth bass, largemouth bass, bluegill, and rock bass. Other species consisted mostly of redhorse and white sucker. Only one carp was taken.

The principal species of wildlife in the watershed are songbirds, deer, rabbits, quail, fur bearers, and other small mammals. Most of the deer population is concentrated in the wooded areas surrounding Cagles Mill Reservoir, as indicated by the Indiana Department of Natural Resources wildlife population information. Rabbits are fairly well distributed with fair to good population in the middle reaches of the watershed. The quail population is fair to good, with distribution concentrated near the middle and upper reaches.

WATERSHED PROBLEMS

Floodwater Damage

The Mill Creek channel from Cataract Lake to Owen-Putnam County line is in an entrenched narrow valley and does not have capacity to carry flood waters from even small storms. The resulting upstream floods cause damage to crops and pasture, agricultural land and improvements, and inundates roads, making them impassable.

The June 1960 flood, one of the largest recent floods, inundated approximately 18,600 acres. About 6420 acres were covered with water in Lake Ditch area, 3425 along Mud Creek, 1210 from Amo to Stilesville, 6696 from U.S. Highway 40 to Indiana Highway 42, and 850 downstream from Indiana Highway 42. Direct damages to crop and pasture on 14,366 acres of the 18,600 inundated acres is estimated to have been $465,000. Inundation of Indiana Highway 42 over 2' deep and remaining nearly 2 days, and inundation of county roads isolated the Eminence community from the north and west.

Yearly floods top existing levees. Floods occur one to three times during the cropping season. Because of the restricted outlet conditions, there is duration of flooding from one to four days. Roads throughout the watershed are closed because of flooding, causing interruption of transportation in some areas for several days.

Average annual floods inundate approximately 12,500 acres causing a direct damage of $318,978 to crop and pasture, and of $18,600 to other agriculture and road and bridges. Average annual indirect damage is estimated at $33,758. Thus, the average annual damage is estimated at $371,336.

Sediment Damage

Sediment damages, in relation to floodwater damages, are not significant. There are scattered areas of infertile sediment deposits on agricultural land, caused by occasional levee breaks and excessive

channel meanders. Infertile overwash was studied but proved to be insignificant in monetary terms. Channel sloughing occurs along lower Mud Ditch and Lake Ditch due to high sand content in the banks. This sediment deposited directly into the channels, plus sediment from upstream sheet and channel erosion, reduces the effective channel capacity. Channel cleanouts have been made in the past and will be necessary in the future to maintain adequate capacity. Sediment damage due to channel filling in Lake Ditch was evaluated; however, benefits derived from damage reduction are not appreciable and were not used for project justification.

Suspended sediment, during and after flooding, causes a high degree of turbidity in lower Mill Creek and in Cagles Mill Reservoir. The annual sediment yield from the watershed to Cagles Mill Reservoir is approximately 295,500 tons, based on a 1962 survey (10-year record) by the U. S. Corps of Engineers.

Erosion Damage

Land damage from upland erosion is negligible. Sheet erosion is the main upland sediment source and amounts to about one-fiftieth of one inch annually from the entire watershed. There are no major gully developments in the watershed. Streambank erosion occurs in the upper reaches of most of the major channels and on small tributaries along Lake and Mud Ditches.

Sheet erosion and streambank erosion, with bank sloughing, are the major sources of downstream channel sediment deposits.

Scour occurs along the Mill Creek floodplain with some local severity. However, these areas will be subject to future flooding and were not monetarily evaluated. Areas of erosion damages are included in crop and pasture evaluations.

Problems Relating to Water Management

The local people have stressed a need for small water-based recreational areas within the watershed, and have requested that such lakes be included in the plan. Their considerations for recreational developments included the number of people who would take advantage of the proposed developments, the availability of existing facilities, and the effect of the development upon the community.

The 1960 population within 25 miles of the town of Amo was about 285,000. The watershed lies within 20 miles of the city of Indianapolis. Water for recreational use would be available to over 1,000,000 population.

within a 50 mile range. The nearest facilities to the watershed are two U. S. Corps of Engineers' Reservoirs, Mansfield about 25 miles to the northwest, and Cagles Mill on the western watershed boundary. McCormicks Creek State Park and Morgan-Monroe County State Forest are situated about 30 miles to the south. There are no state or federally owned public recreation facilities within 50 miles of the watershed to the north or east.

The local people would like to develop an area for fishing, boating, hiking, picnicking, and camping. Available public facilities such as these, situated between two federal highways, U. S. 36 and U. S. 40, would attract visitors from the small surrounding communities as well as from the more populous areas.

PROJECTS OF OTHER AGENCIES

There are no other projects planned or being considered in the Mill Creek Watershed by other agencies. At the terminus of this watershed project there is an operating structure, Cagles Mill Dam of the U. S. Corps of Engineers and the State of Indiana providing benefits to flood control and recreation. The works of improvement of this project end just above the Upper Cataract Falls which are located at the upper part of Cagles Mill Reservoir.

BASIS FOR PROJECT FORMULATION

The inherent fertility and high quality soils of the floodplain areas, the frequent and damaging floods, the blocking of tributary channels used for land drainage, future water supply, and the need for additional recreation facilities were all critical items of consideration in project formulation. The flood protection provided to about 18,600 acres will provide stability to the agriculture of the area that is very lacking now.

There was a desire by the local leaders for as high a degree of protection as could be attained within economic feasibility. Combinations of structures, varying degrees of channel improvement, and a high level of land treatment were studied. The volume of runoff required to be handled from the 292 square miles required extensive channel enlargement and improvement after realizing the maximum control practical from land treatment and retarding structures. In some reaches (reach P - Mud Creek is an example) it was necessary to depend upon

channel improvement alone due to the lack of sites for retarding structures. For other reaches combinations of retarding structures and channel improvement were practical and are included in the plan.

Studies and investigations were carried out to determine potential for water supply storage for use by Stilesville and Cloverdale. All sites that were considered were judged to be impractical by the local officials.

Several combinations of measures were considered and given careful study by the local leaders. The measures included are those determined to be most desirable by local interests and to more nearly meet their objectives. The level of protection provided is for the 3-year frequency storm during the cropping season.

The major purpose and benefits of the project is flood prevention, but there are substantial benefits to recreation.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures

The Owen, Parke, Montgomery, and Putnam Soil and Water Conservation Districts are carrying out an active soil and water conservation program. This program, based upon the use of each acre of agricultural land within its capabilities and its treatment in accordance with its needs, is an essential part of watershed protection. The districts' program, to be accelerated during the project installation period, stresses basic conservation plans as the basis for the systematic application of needed land treatment measures. The resulting watershed protection will be effective in reducing sediment accumulation in the floodwater and multi-purpose reservoirs, will aid in the reduction of floodwater damages, and will rpovide direct benefits to those installing the measures.

Already 567 farmers are cooperating with the Soil and Water Conservation Districts, 267 farmers have developed basic conservation plans, and they have spent $1,966,053 to install land treatment measures (Table 1A). By the end of the eight year project installation period, over 75 percent of the landowners will have developed basic conservation plans and will have applied a high percentage of the planned soil and water conservation measures. In some instances group enterprises are needed to install these measures.

Table 1 shows estimates of the acreage in each major land use upon which conservation treatment will be applied. Treatment on the 63,408 acres of cropland will include: Contour farming, grade stabilization, and erosion control structures to reduce erosion; conservation rotation and tillage practices for the improvement of the physical, chemical, and biological condition of the soil; tile and open ditches, surface drains, diversion terraces, and grass waterways for orderly removal of excess water; wildlife development, ditch bank seeding, and border planting to enhance wildlife habitat.

Treatment on the 3,350 acres grassland will include pasture planting and renovation, and farm ponds. Woodland treatment on 9,420 acres will include exclusion of livestock, reforestation, and improved forestry practices. Treatment of the 76,178 acres can be done by alternative measures. For example, on cropland acres needing erosion control, an extensive rotation, diversions, contour farming, minimum tillage, or a combination of these practices would accomplish the same purpose. Landowners will spend an estimated $1,275,966 to apply the needed conservation measures.

The land treatment measures will be established and maintained by the farmers in the watershed with assistance provided through the four Soil and Water Conservation Districts. In addition to the $240,105 now available for technical assistance, $457,781 including $36,713 for soil surveys on 102,780 acres, will be made available from PL-566 funds to accelerate the establishment of land treatment. Table 1 shows the cost of technical assistance to be furnished by the Soil Conservation Service and the Indiana Department of Natural Resources in cooperation with the U. S. Forest Service.

Structural Measures

The structural measures included in the plan, as shown on the project map consist of fourteen floodwater retarding structures and channel improvement. Twelve structures are single purpose floodwater retarding; two structures are multipurpose recreation and floodwater retarding, along with 53.31 miles of single purpose flood prevention channel improvement. Structure No. 9 will be a public recreational development.

All floodwater retarding and multipurpose structures will be earth fill dams, with the principal spillways of a reinforced concrete inlet and a reinforced concrete conduit, except structures No. 20, 21 and 22 which will have corrugated metal pipe inlets and conduits. Structures 1, 3, 4, 7, 8, 9, 10, 20, 21, and 22 have two stage inlets, detaining one inch of runoff between the low stage inlet and

the high stage inlet; structures 2, 6, 18 and 19 have single stage inlets. The pool areas reserved for sediment in these structures were designed on the expected 50 year accumulation of 1209 acre feet, covering a surface area of 333.5 acres. Structures 18, 19 and 21 are designed to dewater the sediment pool after each rain. These structures are designed to temporarily detain 7,224 acre feet of floodwater which is equivalent to 2.69 inches of runoff from the drainage area above these structures. The design data for each structure is given in Table 3. Figure 1 shows a typical floodwater retarding structure with drawdown. Floodwater retarding structures will control 20 percent of the watershed area above the Cagles Mill Reservoir.

The multipurpose structures 3 and 9 provide for permanent recreational water and temporary floodwater detention.

The recreational portion of structure No. 3 contains 320 acre feet of permanent water with a surface area of 65 acres.

The recreation portion of structure No. 9 contains 1,375 acre feet of permanent water with a surface area of 140 acres. Recreational land surrounding the lake is 409 acres, of which the recreational facilities are located on 62 acres. The basic recreational facilities are as follows: All weather roads, boat docks, launching ramps, camp sites, parking areas, water wells, modern sanitary and bathing facilities, picnic tables and grills.

The total installation cost of all structures is estimated to be $1,511,880. The cost distribution may be found in Table 2.

Geologic and soil conditions appear satisfactory with sufficient borrow material available. Prior to final design detailed geologic investigations will be made at all sties.

Sediment storage requirements as estimated should be reviewed by individual structure prior to final design.

The channel improvement is single purpose flood prevention, consisting of 32.44 miles of channel excavation, 3.72 miles of minor channel excavation and shoal removal, 4.97 miles of clearing, snagging and shoal removal, and 12.18 miles of clearing and snagging.

The side slopes, berms and spoil banks mabe be selectively seeded to approved varieties, to provide the designed channel flows, control erosion and improve wildlife habitat.

Fifteen grade stabilization sills are planned on Mud Creek. Several different types of problems exist. Poorly graded sand is located in the lower banks and bottom. The channel is narrow and deep, the bottom is degrading with excessive velocities, and the banks are sloughing from erosion.

These fifteen grade stabilization sills will raise the channel grade above each sill one to two feet, thereby decreasing or eliminating the sand and degradation problem, permitting the designed channel to flow within the allowable velocities, and decreasing erosion and bank sloughing.

The channels are designed to contain within bank the three-year frequency cropping season floods.

The total estimated installation cost of the works of improvement for the channels is $3,438,000. The cost distribution is listed in Table 2. The design data for channel improvement is located on Table 3A. Figure 2 shows a typical channel cross-section, and the perspective view of the channel and spoil leveling. Figure 3 shows a perspective view of the grade stabilization sills.

EXPLANATION OF INSTALLATION COST

Land Treatment Measures

The cost of land treatment on the acres to be treated during project period is summarized in Table 1, The funds necessary for technical assistance for acceleration of the land treatment program will be provided by PL-566 funds. This is estimated to be $457,781. The assistance for the going land treatment program is $221,415. The technical assistance available from the Indiana Department of Natural Resources, Division for Forestry in cooperation with the U. S. Forest Service amounts to $18,690. The cost of treatment of acres shown in Table 1 will be met by landowners and operators on whose farms conservation treatment will be applied.

Structural Measures

Project installation costs include all Public Law 566 and Other costs for installation of these works of imrpovement. These costs are shown on Table 2 as construction, installation services, administration of contracts and land, easements and rights-of-way.

Construction costs are the engineers' estimate of the cost of all materials and labor involved in the construction of the structural measures. Unit costs were calculated on the basis of current prices for similar construction work in Indiana, and compared with bid abstracts of PL-566 projects in Indiana. A 15 percent contingency cost was added to defray any additional cost that may arise in construction. The estimated PL-566 construction cost is $2,906,637 and the other than PL-566 cost is $90,533.

Installation services include engineering and other services. Engineering services include the services of engineers and geologists used in designing and installing the structural measures, including the cost of construction surveys, preparation and interpretation of plans and specifications, and for inspection of construction work. Other services include overhead costs for structural measures, as well as direct costs for installation services provided by other than engineers and geologists. These costs amount to $1,008,333 to be paid from PL-566 funds, and $16,077 from Other funds.

Administration of contracts include all costs for administrative, legal, and clerical services incurred by the local contracting organization, and amounts to $34,300.

Land, easements and rights-of-way include the following costs:

1. All expenditures made in acquiring land, easements and rights-of-way.

2. All expenditures for purchase, removing or relocation of buildings or other improvements.

3. All expenditures for the relocation of private and public roads or permission to close or flood these roads.

4. All expenditures made to stabilize, move or maintain all types of public utilities or permission to flood same.

5. Replacement or modification of existing highway, road and railroad bridges, culverts and their approaches.

6. Relocation and construction of fences and farm bridges within the rights-of-way.

The amount of PL-566 funds cost-shared for fee simple purchase of land is $58,420, involving recreation land for structure No. 9. The Sponsoring Local Organization cost for land, easement and rights-of-way is $835,580.

Multipurpose Recreation and Floodwater Retarding Structures

Structure No. 3 - Construction costs for structure No. 3 will be cost-shared by the Mill Creek Conservancy District and PL-566 funds. The Other cost is $22,515 and the PL-566 cost is $73,285. Included in the Other cost are all costs allocated to recreation.

The installation services cost of $27,923 will be borne by PL-566 funds and $8,577 will be borne by the Mill Creek Conservancy District. Administration of contracts amounting to $2,900, and land, easement and rights-of-way amounting to $39,000 are to be assumed by the Mill Creek Conservancy District. The total PL-566 cost is $101,208, and the total Other cost is $72,992, for a total structure cost of $174,200. No PL-566 cost-share for recreation was requested by the Sponsors.

Structure No. 9 - The construction cost for structure No. 9 is cost-shared by the Mill Creek Conservancy District, the Indiana Department of Natural Resources, and PL-566. The Other cost is $35,518; the PL-566 cost is $88,452. The installation services cost of $47,110 will be borne by PL-566 funds.

Administration of contracts will be borne by Other funds and amounts to $1,700.

Land, easements and rights-of-way are cost-shared by the Sponsoring Local Organization and PL-566 funds. Land acquisition fees will be borne by other funds. The Other cost is $51,000; the PL-566 cost is $49,000.

The basic recreational facilities are cost-shared by the Sponsoring Local Organization and PL-566. The Other cost for construction is $32,500; the PL-566 cost is $32,500. Land easements and rights-of-way costs are $9,420 for PL-566 and $90,680 for Other. Installation service costs of $7500 and administration of contract costs of $2500 will be borne by Other funds.

The cost-sharing percentages for the structure are as follows: The construction costs for the structure, allocated to recreation are cost-shared 50 percent by the Sponsoring Local Organization and 50 percent by PL-566; that portion allocated to flood prevention and all installation services are 100 percent PL-566 costs. The total costs of land, easements and rights-of-way are cost-shared 29.2 percent by PL-566 and 70.8 percent by the Sponsoring Local Organization. The construction costs for basic recreational facilities are cost-shared 50 percent by the Sponsoring Local Organization and 50 percent by PL-566, while installation services and administration of contracts are 100 percent Other cost.

The total PL-566 cost for structure No. 9 is $184,562 and the Other cost is $88,218 for a total installation cost of $272,780. The total PL-566 cost for basic recreational facilities is $41,920 and the Other cost is $133,180, for a total cost of $175,100.

Installation Schedule

The installation of the project is planned to be accomplished in a period of eight years.

An estimated schedule of Federal and Non-Federal obligations by fiscal years is as follows:

Fiscal Year	PL-566 (Dollars)	Other (Dollars)	Total (Dollars)
First Year			
Structures 1, 2, 3, 4, 6, 7 & 8 - Channel Reach DD			
Installation Services	110,753	8,577	119,330
LE & RW		177,500	177,500
TOTAL STRUCTURAL MEASURES	110,753	186,077	296,830
LAND TREATMENT	38,000	230,400	268,400
TOTAL	148,753	416,477	565,230
Second Year			
Structures 1, 2, 3, 4, 6, 7 & 8 - Channel Reach DD			
Construction Contracts	673,685	22,515	696,200
Administration of Contracts		8,100	8,100
Installation Services	83,870		83,870
Structures 9, 10 & 19			
Installation Services	64,680		64,680
LE & RW	58,420	290,680	349,100
TOTAL STRUCTURAL MEASURES	880,655	321,295	1,201,950
LAND TREATMENT	65,000	230,400	295,400
TOTAL	945,655	551,695	1,497,350

Fiscal Year	PL-566 (Dollars)	Other (Dollars)	Total (Dollars)
Third Year			
Structures 9, 10 & 19			
Construction Contract	226,152	35,518	261,670
Basic Facilities - 9	15,500	14,000	29,500
Adminis. of Contract		5,600	5,600
Installation Service	34,830	3,000	37,830
Structures 18, 20, 21 & 22 Channel Reaches BB, CC & Z			
Installation Services	106,080		106,080
LE & RW		107,400	107,400
TOTAL STRUCTURAL MEASURES	382,562	165,518	548,080
LAND TREATMENT	75,000	230,400	305,400
TOTAL	458,562	395,918	853,480
Fourth Year			
Structures 18, 20, 21 & 22 Channel Reaches BB, CC & Z			
Construction Contract	631,300		631,300
Basic Facilities - 9	17,000	18,500	35,500
Administration of Contracts		6,600	6,600
Installation Service	99,120	4,500	103,620
Channel Reaches X, V & W			
Installation Service	44,500		44,500
LE & RW		33,000	33,000
TOTAL STRUCTURAL MEASURES	791,920	62,600	854,520
LAND TREATMENT	75,000	230,400	305,400
TOTAL	866,920	293,000	1,159,920
Fifth Year			
Channel Reaches X, V & W			
Construction Contract	235,000		235,000
Administration of Contract		3,000	3,000
Installation Service	44,500		44,500
Channel Reaches Q & T			
Installation Services	99,500		99,500
LE & RW		93,000	93,000
TOTAL STRUCTURAL MEASURES	379,000	96,000	475,000
LAND TREATMENT	72,781	148,618	221,399
TOTAL	451,781	244,618	696,399

Fiscal Year	PL-566 (Dollars)	Other (Dollars)	Total (Dollars)
Sixth Year			
Channel Reaches Q & T			
Construction Contracts	526,000		526,000
Administration of Contract		5,000	5,000
Installation Service	99,500		99,500
Channel Reaches K, L, & T			
Installation Service	35,000		35,000
LE & RW		50,000	50,000
TOTAL STRUCTURAL MEASURES	660,500	55,000	715,500
LAND TREATMENT	44,000	148,618	192,618
TOTAL	704,500	203,618	908,118
Seventh Year			
Channel Reaches K, L, & T			
Construction Contract	186,000	(10,000) 1/	186,000
Administration of Contracts		2,000	2,000
Installation Service	35,000		35,000
Channel Reaches I, J & P			
Installation Service	75,500		75,500
LE & RW		84,000	84,000
TOTAL STRUCTURAL MEASURES	296,500	86,000	382,500
LAND TREATMENT	44,000	148,618	192,618
TOTAL	340,500	234,618	575,118
Eighth Year			
Channel Reaches I, J & P			
Construction Contract	396,000	(40,000) 1/	396,000
Administration of Contract		4,000	4,000
Installation Service	75,500		75,500
TOTAL STRUCTURAL MEASURES	471,500	4,000	475,500
LAND TREATMENT	44,000	148,617	192,617
TOTAL	515,500	152,617	668,117
GRAND TOTAL			
STRUCTURAL MEASURES	3,973,390	976,490	4,949,880
LAND TREATMENT	457,781	1,516,071	1,973,852
TOTAL	4,431,171	2,492,561	6,923,732

1/ Non-Project Cost - Bridges

Non-Project Costs

Anticipated non-project costs consist of county bridge replacements. These bridges numbered two and three on Mud Creek and bridge numbered six on Lake Ditch are located in Morgan County. The estimated cost for replacing these bridges is $50,000. These bridges need replacement, are considered inadequate by the County Commissioners, and are determined by them to have served their useful life.

Additional costs resulting from changes of or additions to project works of improvement for non-project purposes or maintenance will be considered non-project costs, such as: Distributing and leveling spoil or disposing of excavated material primarily to improve land, filling abandoned channels or depressed areas outside of rights-of-way, constructing maintenance road and associated culverts, relocating or modifying planned works of improvement for the convenience of the Sponsoring Local Organization.

EFFECTS OF WORKS OF IMPROVEMENT

The installation and maintenance of land treatment measures will provide on-site conservation benefits. These measures provide for efficient and effective soil management procedures, for soil tilth improvement, for water management, for increased water filtration, for use of land within its capability, and for erosion reduction. Sheet erosion rates will be reduced by approximately twenty-five percent. Installation of land treatment and structural measures will reduce downstream sediment deposition by about fifteen percent. In addition to the reduced soil erosion and sedimentation, conservation treatment will cause the soil to absorb more water and thereby reduce peak flows. The 200 farmers in the evaluated area and the other 1000 farmers in the watershed will benefit from applied land treatment measures.

Small game losses resulting from flash floods during the nesting season will be reduced. Application of land treatment measures including grass waterways, farm ponds, improved forestry practices, ditch bank seeding, and development of wildlife habitat will enhance the distribution of game cover in cropland areas adjacent to plentiful quantities of food. Acquatic wildlife habitat will be increased by the 375 surface acres of water created by installation of the 14 impoundments and by the water in about 200 farm ponds. These impoundments will provide over 50,000 angler days per year.

The planned structural measures will provide flood protection to over 18,000 acres of farmland. The flooding that presently occurs one to three times during the cropping season year will be reduced to once in three years. With the exception of Reach DD and the lower parts of CC, three (3) year frequency (cropping season) storms will be contained within channel banks.

Because of frequent flooding, farmers are presently unable to use high management practices. On 9,130 acres now being flooded that will be flood free for the three-year cropping season storm, farmers will perform operations in a more timely manner, will increase production inputs, and will allow use of needed conservation measures. Consequently, 200 farmers will enjoy the benefits of more intensive land use.

The farmers are dependent upon the production of agricultural crops as the primary basis for their farm business. The reduced flooding will permit higher economic efficiencies for the farm enterprise and higher income on the farms affected. The increase in the economy of the watershed will benefit the community directly and also benefit the economy in the trade areas outside the watershed.

The suppliers of farm materials and equipment will receive additional income due to the need for more fertilizer, seed and lime to make possible the intensive land use due to the project. The increase in farm income will go indirectly to retailers and wholesalers in the community as additional expenditures by the farm family. There will also be increased income to people who provide services for processing, marketing and transporting the increased production due to the project. The operation and maintenance cost will be additional income to people who provide this service.

The recreational use for structure No. 9 will be fishing, camping, picnicking, hiking and boating. The recreational season would be all year. The number of people benefited from the project includes 12,978 fishermen and 15,697 other or a total of 28,595 annually. It is estimated that the visitors to be accommodated will be 600 per peak day. For structure No. 3 the recreation will be limited to fishing. It is estimated that there will be 6,500 fishermen annually for this site. Organized groups or the public will use the recreational facilities, incidental to the project, at about one-third of the 270 acres sediment pools impounded by the 12 floodwater retarding structures. An estimated 10,800 visitor days use are expected to make use of these facilities.

PROJECT BENEFITS

There will be 18,600 acres benefited by damage reduction from the project. Of the 18,600 acres there will be 14,366 acres of cropland benefited. The damage reduction benefits with project amount to $265,586. On the 9,130 acres of cropland that will be flood free for the 3-year cropping season storm with the project, other agricultural benefits to fences, machinery, buildings, and livestock amount to $13,300. Indirect benefits are $24,144 and benefits to crop and pasture amount to $228,142. The more intensive land use benefits are $49,140.

Non-agricultural benefits are from savings in bridge costs with project of $5,110 annually.

The recreational benefits to structure No. 9 amount to $35,745. The number of annual visitor days with projected population is 28,595; the value per day is $1.25. For structure No. 3 the benefits are $3,013; with annual visitor days of 6,500 and value per day of $0.50. Incidental recreation benefits to the single purpose floodwater retarding structures amount to $2,161, Secondary benefits which stem from and are induced by the project, are $40,560.

The total of all benefits to the project from structural measures are $388,035.

COMPARISON OF BENEFITS AND COSTS

The summary of benefits and cost comparison for structural measures is shown in Table 6. The estimated average annual benefits to cost ratio for all works of improvement is 1.6 to 1.0.

PROJECT INSTALLATION

Land Treatment Measures

The Sponsoring Soil and Water Conservation Districts will assume the responsibility for the application of the land treatment. The installation of all land treatment measures will be accomplished within an eight-year period. The Soil Conservation Service will provide personnel to assist the Soil and Water Conservation Districts in providing landowners and operators technical assistance to develop basic farm plans and the installation of planned practices.

Technical assistance for the forestry measures will be furnished by the Indiana Division of Forestry in cooperation with the U. S. Forest Service. The measures will be installed by private landowners and operators. Technical assistnace will be provided under the accelerated program by the Service forester and financed by State funds and matching PL-566 funds.

Structural Measures

All works of improvement will be installed during a eight-year period. In order to realize the most benefits from the structural measures, they will be installed in the following sequence:

Second Year - Floodwater retarding structures 1, 2, 4, 6, 7, and 8, multipurpose recreation and floodwater retarding structure 3 and channel improvement Reach DD.

Third Year - Floodwater retarding structures 10 and 19, multi-purpose recreation and floodwater retarding structure 9, including a portion of the basic recreation facilities.

Fourth Year - Floodwater retarding structures 18, 20, 21 and 22, channel improvement Reaches CC, BB and Z. Complete the basic recreation facilities on multipurpose structure 9.

Fifth Year - Channel improvement Reaches X, V and W.

Sixth Year - Channel improvement Reaches Q and U.

Seventh Year - Channel improvement Reaches K, L and T.

Eighth Year - Channel improvement Reaches I, J and P.

The Mill Creek Conservancy District being formed under State Laws will be responsible for securing land, easements and rights-of-way for the proposed works of improvement.

Installation service costs for basic recreational facilities at structure No. 9, and that portion of structure No. 3 installation allocated to recreation, will be paid by Otherfunds. All other installation services for designing and installing the works of improvement as listed in Tables 3 and 3A, will be provided by the Soil Conservation Service.

Contracts for installation of works of improvement will be administered by the Mill Creek Conservancy District. This legal organization will have power of eminent domain and fund raising by taxation and will use this authority when necessary.

As co-sponsors, the Hendricks, Morgan, Owen and Putnam County Soil and Water Conservation Districts will provide such assistance and guidance as necessary to expedite coordination between the land treatment and structural features of this plan.

The Indiana Department of Natural Resources, in accordance with State Laws and Regulations will review for approval, the plans and specifications for the works of improvement to be constructed.

FINANCING PROJECT INSTALLATION

Land Treatment Measures

The Soil and Water Conservation Districts for Putnam, Hendricks, Morgan and Owen Counties will be responsible for the application of the land treatment program shown in Table 1. The Boards of Supervisors of the four Districts will make full use of available resources to accelerate land treatment activities to make certain that needed measures are applied during the 8-year installation period. Landowners and operators, in cooperation with the Districts, will apply land treatment measures on their farms and will bear the installation cost of these measures. The cost to landowners for these measures amount to $1,275,966. The District will continue to encourage landowners and operators to apply and maintain the needed conservation practices for protection and improvement of the watershed.

Table 1 lists the area of land programed for treatment and costs separated into cropland, grassland and woodland. The technical assistance for installing forestry measures will cost $34,490 of which $15,800 will be provided under the authority of PL-566, $15,150 will be provided by the Indiana Department of Natural Resources, Division of Forestry, and $3,540 will be provided by the Indiana Department of Natural Resources in cooperation with the U. S. Forest Service through the going Cooperative Forest Management Program. The State will begin cooperation with its funds at the earliest possible date. However, if it does not have funds for cost-sharing during the first year of installation, the Forestry technical assistance during this period will be furnished wholly from PL-566 funds.

It is expected that Agricultural Conservation Program (ACP) cost-sharing will be available to qualified landowners for installing land treatment measures.

Structural Measures

Installation of the structural measures in the Plan will be the responsibility of the Mill Creek Conservancy District. All work will be done by contract which will be administered by the Conservancy District.

This Conservancy District will have the authority to levy an annual tax, make exceptional benefit assessments, acquire necessary easements and rights-of-way by purchase, grants, bequests, or theough condemnation proceedings, construct, improve, operate and maintain the structural works of improvements, and borrow money, issue, negotiate and sell bonds. The Conservancy District will exercise these authorities to raise all necessary funds to install, operate, and maintain the structural measures. When necessary the Conservancy District will initiate condemnation proceedings.

Any expenses incurred in establishing the Conservancy District will be borne locally. The Conservancy District will receive a loan form the Farmers Home Administration which can be used to meet other costs except the private recreation costs involved in structure No. 3. A letter of intent has been filed with the State Director of the Farmers Home Administration and is the first step in securing a loan from that Agency to finance local costs.

The other than PL-566 cost for the installation of structural measures is estimated to be $976,490 as shown in Table 1. This figure includes $90,533 for construction cost, $835,580 for the necessary land, easements and rights-of-way, $34,300 for administration of contracts, and $16,077 for installation services. Agencies of State Government are interested in the recreational developments and will provide funds to assist the Conservancy District amounting to $165,982 from the Indiana Department of Natural Resources.

Federal assistance for carrying out the works of improvement described in this plan will be provided under Authority of the Watershed Protection and Flood Prevention Act, PL-566, 83rd Congress, 68th Stat. 666. Federal assistance from PL-566 funds is contingent upon fiscal year appropriation for carrying out projects authorized for operation under PL-566.

PROVISION FOR OPERATION AND MAINTENANCE

Land Treatment Measures

Land treatment measures will be maintained by landowners or farm operators. This will be accomplished under District Cooperators' agreements with the four Soil and Water Conservation Districts (Putnam, Hendricks, Morgan, and Owen). Forestry measures after completion of the PL-566 project will be maintained by landowners and operators with technical assistance provided by the Indiana Department of Natural Resources, Division of Forestry, in cooperation with the U. S. Forest Service under the going Cooperative Forest Management Program.

Structural Measures

The twelve single purpose floodwater retarding structures and the two multipurpose recreation and floodwater retarding structures along with 53.31 miles of single purpose flood prevention channel improvement will be operated and maintained by the Mill Creek Conservancy District.

The annual cost of operation and maintenance will be $1,662 for the twelve single purpose floodwater retarding structures.

The annual cost of operation and maintenance for the two multipurpose recreation and floodwater retarding structures are proportioned as follows:

Structure No. 3 - The cost of operation and maintenance allocated to floodwater is $300.

Structure No. 9 - The cost of operation and maintenance allocated to floodwater is $530 and to the basic recreational facilities, $8,925. The recreational facilities requiring replacement are picnic tables, grills, toilets, boat docks, roads and parking areas.

Other recreational facilities requiring periodical and daily maintenance are custodial, policing, sanitation, safety and other numerous items.

The annual cost of operation and maintenance for the single purpose flood prevention channel is $37,867.

The total annual cost of operation and maintenance is $49,284.

Annual inspections will be made of the structural and channel works of improvement. Special inspections will follow severe or other intensive storms or other damaging incidents that may occur.

The inspections will be made by the Board of Directors or a designated representative of the Mill Creek Conservancy District. A representative of the Soil Conservation Service will make inspections with the representative from the local organization, if possible, although separate inspection may be made. The Conservancy District will maintain a record of inspections with one copy filed by the District and another submitted to the Soil Conservation Service.

All costs for labor, equipment and materials for the operations and maintenance of the structural measures will be furnished by the Conservancy District.

Specific operation and maintenance agreements between the Soil Conseraation Service and the Mill Creek Conservancy District will be executed prior to the issuance of invitations to bid on construction contracts.

The continued functioning of the proposed structures and channels for the purpose for which they were designed will require a timely maintenance program. This will necessitate the control of undesirable vegetative growth by mowing and/or spraying; re-sloping, reseeding and fertilizing of eroded structure side slopes, channel banks and berms; and the removal of debris blocks and sediment bars in channels and the entrance of spillways.

An estimate of annual installation and operation and maintenance costs are shown in Table 4.

TABLES 1, 1A, 2, 2A, 2B, 3, 3A, 4, 5 and 6

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

Mill Creek Watershed, Indiana

Installation Cost Item	Acres to be Treated	Estimate Cost (Dollars) 1/		
		PL-566	Other	
		Non-Fed. Land	Non-Fed. Land	Total
(1)	(2)	(3)	(4)	(5)
Land Treatment				
Soil Conservation Service				
Cropland	63,408		988,266	988,266
Grassland	3,350		253,800	253,800
Technical Assistance		441,981 2/	221,415	663,396
SCS Subtotal		441,981	1,463,481	1,905,462
Forest Service				
Woodland	9,420		33,900	33,900
Technical Assistance		15,800	18,690 3/	34,490
FS Subtotal		15,800	52,590	68,390
TOTAL LAND TREATMENT	xxxx	457,781	1,516,071	1,973,852

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

Mill Creek Watershed, Indiana

Installation Cost Item	Unit	Number	Estimated Cost (Dollars) 1/		
			PL-566	Other	
		Non-Fed. Land	Non-Fed. Land	Non-Fed. Land	Total
(1)	(2)	(3)	(4)	(5)	(6)
STRUCTURAL MEASURES					
Construction					
Soil Conservation Serv.					
Floodwater Retarding Structures	No.	12	413,400		413,400
Multiple Purpose Structures	No.	2	161,737	58,033	219,770
Basic Facilities	Dev.	1	32,500	32,500	65,000
Channel Improvement	Mi.	53.31	2,299,000		2,299,000
Subtotal - Const.	xxx	xxxx	2,906,637	90,533	2,997,170
Installation Service					
Soil Conservation Serv.					
Engineering Service			680,467	16,077	696,544
Other			327,866		327,866
Subtotal-Inst.Serv.			1,008,333	16,077	1,024,410
Other Cost					
Land,Easement & RW			58,420	835,580	894,000
Adminis. of Contracts				34,300	34,300
Subtotal - Other Cost			58,420	869,880	928,300
TOTAL STRUCTURAL MEASURES			3,973,390	976,490	4,949,880
TOTAL PROJECT			4,431,171	2,492,561	6,923,732
SUMMARY					
Subtotal - SCS			4,415,371	2,439,971	6,855,342
Subtotal - FS			15,800	52,590	68,390
TOTAL PROJECT			4,431,171	2,492,561	6,923,732

1/ Price base - 1964
2/ Includes $36,713 for accelerated soil survey
3/ Includes $3,540 in technical assistance for State and Federal Cooperative Forest Management Program.

Date: April 1965

TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT

(At time of work plan preparation)

Mill Creek Watershed, Indiana

Measures (1)	Unit (2)	Applied to Date (3)	Total Cost (Dollars)1/ (4)
LAND TREATMENT			
Soil Conservation Service			
Basic Conservation Farm Plan	Number	267	
District Cooperators	Number	567	
Basic Conservation Farm Plans Revised	Number	50	
Standard Soil Survey	Acres	84,355	
Conservation Cropping System	Acres	29,770	
Contour Farming	Acres	1,350	1,350
Diversions	Feet	36,500	5,475
Main & Laterals	Feet	129,000	96,750
Farm Ponds	Number	215	193,500
Grade Stabilization Structure	Number	227	56,750
Grassed Waterway	Acres	76	2,553
Pasture Planting	Acres	1,260	88,200
Pasture Renovation	Acres	790	15,800
Terraces	Feet	68,000	5,100
Tile Drain	Feet	5,857,500	1,464,375
Wildlife Habitation Development	Acres	420	4,200
Border Planting	Feet	11,000	1,100
Ditch Bank Seeding	Feet	100,000	12,000
Surface Field Ditch	Feet	10,000	1,800
SCS Subtotal	xxxx	xxxx	1,948,953
Forest Service			
Livestock Exclusion	Acres	4,000	16,000
Improved Forestry Practices	Acres	100	100
Sustained Yield Practices	Acres	100	100
Cultural Practices	Acres	10	200
Forestation	Acres	20	700
FS Subtotal	xxxx	xxxx	17,100
TOTAL LAND TREATMENT	xxxx	xxxxx	1,966,053

1/ Price base - 1964

Date: April 1965

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TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION

Mill Creek Watershed, Indiana
(Dollars)1/

Structure Site Number or Name	Installation Cost - PL-566 Funds					Installation Cost - Other Funds					TOTAL
	Construction	Installation Services	Easement & R/W	Total PL-566		Construction	Installation Services	Easement & R/W	Adm. of Contracts	Total Other	Installation Cost
(1)	(2)	(3)	(4)	(5)		(6)	(7)	(8)	(9)	(10)	(11)
FWR Str. 1	29,000	11,100		40,100				3,800	300	4,100	44,200
FWR Str. 2	58,900	22,400		81,300				46,000	600	46,600	127,900
MP Str. 3	73,285	27,923		101,208		22,515	8,577	39,000	2,900	72,992	174,200
FWR Str. 4	24,700	9,400		34,100				8,100	300	8,400	42,500
FWR Str. 6	30,800	11,700		42,500				19,300	300	19,600	62,100
FWR Str. 7	32,700	12,500		45,200				15,700	300	16,000	61,200
FWR Str. 8	38,300	14,600		52,900				20,600	400	21,000	73,900
MP Str. 9	88,452	47,110	49,000	184,562		35,518		51,000 2/	1,700	88,218	272,780
Basic Facilities 9	32,500		9,420	41,920		32,500	7,500	90,680 2/	2,500	133,180	175,100
FWR Str. 10	82,700	31,500		114,200				74,800	800	75,600	189,800
FWR Str. 18	28,900	11,000		39,900				43,900	300	44,200	84,100
FWR Str. 19	55,000	20,900		75,900				74,200	600	74,800	150,700
FWR Str. 20	12,900	4,900		17,800				3,300	100	3,400	21,200
FWR Str. 21	8,900	3,400		12,300				2,500	100	2,600	14,900
FWR Str. 22	10,600	3,900		14,500				2,700	100	2,800	17,300
Subtotal FWR & MP Str.	607,637	232,333	58,420	898,390		90,533	16,077	495,580	11,300	613,490	1,511,880
Channel Imp. Main Reach DD	386,000	85,000		471,000				25,000	3,000	28,000	499,000
Main Reach CC	376,000	108,000		484,000				29,000	4,000	33,000	517,000
Main Reach Z	186,000	71,000		257,000				22,000	2,000	24,000	281,000
Main Reach X	55,000	21,000		76,000				6,000	1,000	7,000	83,000
Main Reach V	100,000	38,000		138,000				10,000	1,000	11,000	149,000
Main Reach Q	214,000	81,000		295,000				31,000	2,000	33,000	328,000
Main Reach K	18,000	7,000		25,000				9,000	-	9,000	34,000
Main Reach I	79,000	30,000		109,000				19,000	1,000	20,000	129,000
Higgins Br. Reach BB	8,000	3,000		11,000				4,000	-	4,000	15,000
Cotton Br. Reach L	114,000	43,000		157,000				21,000	1,000	22,000	179,000
Sallust Br. Reach J	21,000	8,000		29,000				8,000	-	8,000	37,000
Mud Creek Reach P	296,000	113,000		409,000		(40,000) 3/		57,000	3,000	60,000	469,000
Lake Ditch Reach U	312,000	118,000		430,000				62,000	3,000	65,000	495,000
Lake Ditch Reach T	54,000	20,000		74,000		(10,000) 3/		20,000	1,000	21,000	95,000
Rhodes Cr. Reach W	80,000	30,000		110,000				17,000	1,000	18,000	128,000
Subtotal Ch. Improv.	2,299,000	776,000	-	3,075,000		-	-	340,000	23,000	363,000	3,438,000
GRAND TOTAL	2,906,637	1,008,333	58,420	3,973,390		90,533	16,077	835,580	34,300	976,490	4,949,880

1/ Price base - 1964

2/ Includes $2,000 for land acquisition

3/ Estimated Nonproject cost for replacement of bridges

Date: September 1964

USDA-SCS-LINCOLN, NEBR. 1966

5,L-21,312

TABLE 2A - COST ALLOCATION AND COST-SHARING SUMMARY

Mill Creek Watershed, Indiana

(Dollars)1/

Item	Purpose		Total
	Flood Prevention	Recreation	
(1)	(2)	(3)	(4)
	COST ALLOCATION		
Single Purpose			
Floodwater Retarding Structures	889,800	-	889,800
Flood Prevention Channels	3,438,000		3,438,000
Multiple Purpose			
Floodwater Retarding Structure and Recreation #3	133,262	40,938	174,200
Floodwater Retarding Structure and Recreation #9	75,176	372,704	447,880
TOTAL	4,536,238	413,642	4,949,880
	COST SHARING		
PL-566	3,819,960	153,430	3,973,390
Other	716,278	260,212	976,490
TOTAL	4,536,238	413,642	4,949,880

1/ Price base - 1964

Date: April 1965

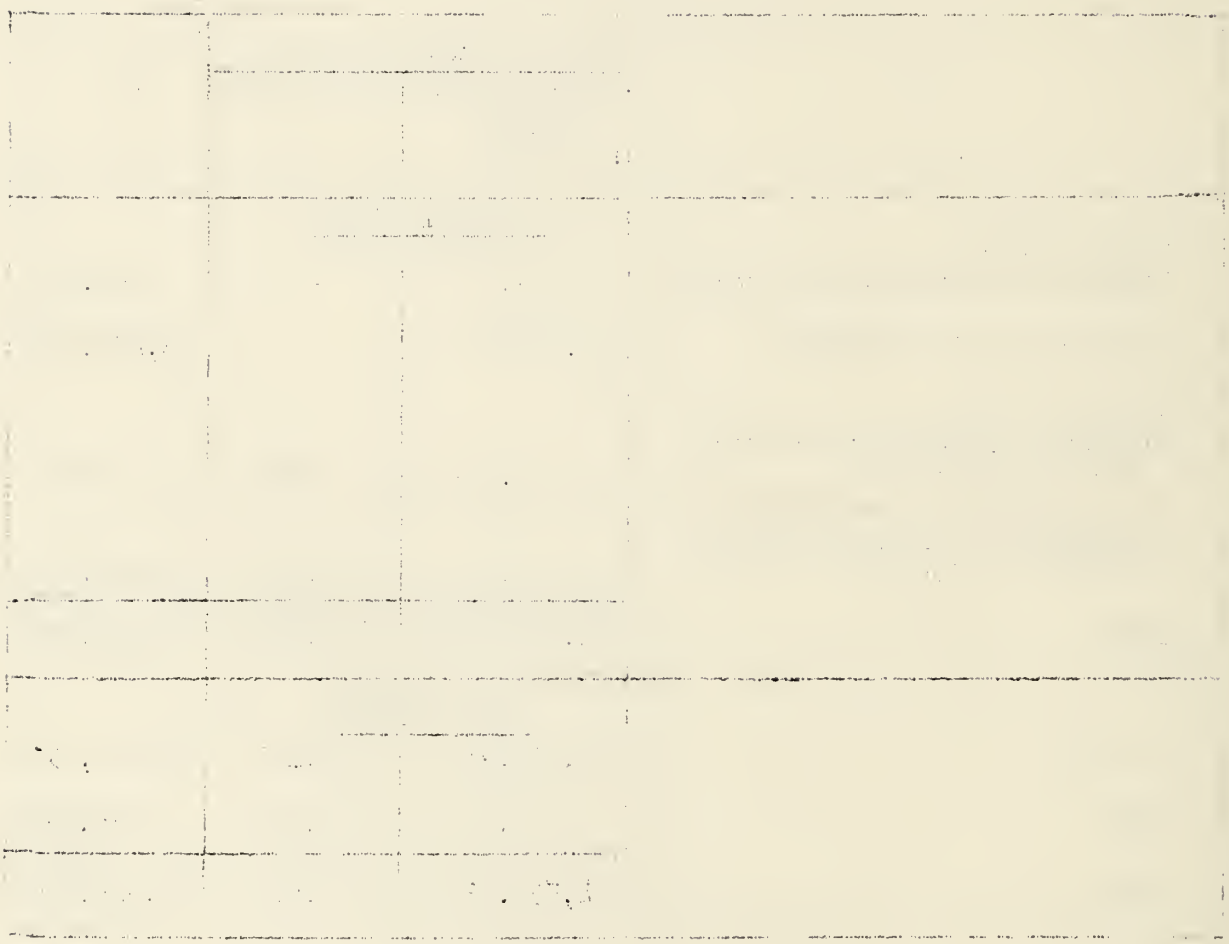


TABLE 2B - ESTIMATED CONSTRUCTION COST OF RECREATIONAL FACILITIES

STRUCTURE #9

Mill Creek Watershed, Indiana

(Dollars) 1/

Type of Facility	Unit	Number	Cost	Inst. Cost
Picnic Area				
Picnic Tables	ea.	20	50	1,000
Grills	ea.	20	25	500
Pit Toilets	Unit	1	1,000	1,500
Camping Area				
Tables	ea.	35	50	1,750
Grills	ea.	35	25	875
Gravel Drive for Cars and/or Trailers	ea.	35	210	7,375
Flush Toilets and Showers	Unit	1	20,000	20,000
Roads	Mi.	1.2	-	20,000
Parking Area (50 cars)	ea.	1	5,000	5,000
Boat Launching Ramp-Concrete	ea.	1	5,000	5,000
Boat Docks for 50 Boats	ea.	1	10,000	10,000
Wells for Drinking Water	ea.	2	1,000	2,000
TOTAL FACILITIES COST	xxx	xxx	xxxx	75,000 2/

1/ Price base - 1964

2/ Includes $7500 for installation services and $2500 for administration of contracts.

Date: April 1965

USDA-SCS-LINCOLN, NEBR. 1965

TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES AND RECREATIONAL RESERVOIRS - MILL CREEK WATERSHED, INDIANA

ITEM	UNIT	STRUCTURE NUMBERS 1	2	3	4	6	7	8	9	10	18	19	20	21	22	Total
Drainage Area - Total	Sq.Mi.	1.12	4.63	5.76	1.71	2.83	1.89	3.07	7.38	8.78	3.58	8.65	0.36	0.33	0.33	50.32
Storage Capacity																
Sediment (Total)	Ac.Ft.	14	74	203	40	82	55	80	202	220	69	120	20	10	20	1209
Below Low Stage	Ac.Ft.	14	66	186	40	75	51	71	178	196	57	106	20	10	20	1090
Recreational Pool	Ac.Ft.			320					1375							1695
Floodwater (To Emergency Spillway Crest)	Ac.Ft.	142	643	836	225	383	249	428	1025	1214	519	1448	44	28	40	7224
Total		156	717	1359	265	465	304	508	2602	1434	588	1568	64	38	60	10128
Between High & Low Stages		60		307	91		107	174	394	511			20	12	18	1694
Surface Area																
Sediment Pool	Acre	5	31	35	9.5	18	23	24	28	48	50	48	6	2.5	5.5	333.5
High Stage	Acre	11.5		97	24.0		34	40	172	95			11	4.5	8	497
Recreational Pool	Acre			65					140							205
Floodwater Pool	Acre	17	92	140	44	64	48	63	217	153	165	212	16	7.5	11	1249.5
Elevations																
Top of Dam	Feet	769.5	781.0	775.0	807.0	801.0	805.0	805.5	851.0	857.0	774.0	780.0	798.0	795.0	798.0	
Crest Emergency Spillway	Feet	767.5	777.0	771.0	805.0	797.0	802.0	802.0	845.5	851.0	771.0	775.0	796.0	792.5	796.0	
Crest Principal Spillway	Feet		763.0			787.0					764.0	765.0				
High Stage	Feet	761.5		764.0	800.5		798.0	797.5	842.5	848.0			794.0	789.5	793.5	
Low Stage	Feet	754.0		760.0	794.5		793.5	793.0	840.0	837.5			792.0	786.0	791.5	
Max. Height of Dam	Feet	25.5	27	35	23	23	25	21.5	39	38	21	24	13	18	13	
Volume of Fill (In 1000's)	Cu.Yds.	16.5	57.0	92.0	15.0	19.0	22.5	28.3	99.0	70.0	19.7	50.0	5.5	12.0	4.0	510.5
Time of Concentration	Hours	1.34	1.50	3.50	1.20	1.86	1.54	1.98	3.55	4.56	1.32	3.56	0.34	0.25	0.15	
Principal Spillway																
Design Storm Duration	Hours	6	51	16	6	18	6	6	12	6	46	60	42	42	42	
Design Storm Rainfall	Inches	4.0	5.86	4.96	4.0	6.15	4.0	4.0	4.64	4.0	5.82	6.18	5.55	5.57	5.5	
Runoff Curve No. (AMC II)		80	80	81	81	80	80	80	80	80	81	82	75	75	75	
Runoff Curve No, (AMC II.5) 3/		87	87	88	87	87	87	87	87	87	87	89	83	83	83	
Storm Runoff (AMC II)	Inches	2.64	3.66	2.96	2.64	3.90	2.64	2.64	2.60	2.64	3.72	4.15	2.89	2.90	2.85	
Capacity (Low Stage) 2/ 4/	c.f.s.	12	73	58	17	66	19	30	74	88	69	120	5	3	5	
Capacity (High Stage)	c.f.s.	80		305	75		78	124	475	458			26	37	26	
Emergency Spillway - Type		Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	
Bottom Width	Feet	115	220	125	160	200	80	225	350	225	110	275	50	50	50	
Percent Chance of Use		4	4	2	4	2	4	4	2	2	4	4	4	4	4	
Emergency Spillway Hydrograph																
Storm Rainfall (6-Hr.)=	Inches	4.0	4.4	7.00	4.4	7.0=	4.4	4.4	7.1	7.0	4.4	4.4	4.4	4.4	4.4	
Storm Runoff (AMC II)	Inches	2.64	2.38	4.80	2.46	4.69	2.38	2.38	4.79	4.69	2.46	2.55	1.97	1.97	1.97	
Velocity of Flow (V_c) 1/	Ft./Sec.	No	No	6.1	No	5.4	No	No	5.5	6.8	No	No	No	No	No	
Discharge Rate	c.f.s.	Flow	Flow	870	Flow	1010	Flow	Flow	1855	2210	Flow	Flow	Flow	Flow-	Flow	
Max. W. S. Elevation 1/	Feet			771.2		798.7			847.3	853.6						
Freeboard Hydrograph																
Storm Rainfall (6-Hr.)	Inches	7.71	10	13.1	8.22	13.1	8.5	9.9	16.77	13.1	9.46	12.59	7.71	7.71	7.71	
Storm Runoff (AMC II)	Inches	5.34	7.52	10.64	5.95	10.52	6.09	7.43	14.11	10.52	7.1	10.28	4.77	4.77	4.77	
Velocity of Flow (V_c) 1/	Ft./Sec.	6.0	8.8	10.8	6.5	19.7	7.6	7.6	10.3	11.8	7.4	9.7	5.8	7.6	5.8	
Discharge Rate	c.f.s.	807	4650	4800	1130	3750	1080	3050	11830	8200	1322	7900	315	450	315	
Discharge Rate Per Hour	Inches	1.12	1.55	1.29	1.02	2.05	0.89	1.54	2.48	1.45	0.57	1.41	1.36	3.03	1.48	
Max. W. S. Elevation 1/	Feet	769.5	781.0	775.0	807.0	801.0	805.0	805.5	851.0	586.8	774.0	780.0	798.0	793.9	798.0	
Capacity Equivalents																
Sediment Volume (Total)	Inches	.23	.30	.66	.44	.54	.54	.49	.51	.47	.36	.26	1.0	.32	1.0	
Recreational Pool Volume	Inches			1.04					3.49							
Detention Volume	Inches	2.37	2.60	2.72	2.47	2.54	2.46	2.61	2.60	2.59	2.72	3.14	2.29	2.29	2.29	
Emergency Spillway Storage	Inches			1.38		0.85			1.20	.89						
Top of Dam - Storage	Inches	3.20	1.50	3.68	I.09	2.70	1.60	1.70	3.80	2.47	2.92	2.60	1.71	2.09	1.41	
Class of Structure		"a"	"a"	"b"	"a"	"b"	"a"	"a"	"b"	"b"	"a"	"a"	"a"	"a"	"a"	

1/ Maximum during passage of hydrograph.

2/ Structures 18, 19 and 21 are designed to have a de-watered sediment pool.

Structure 18 - Capacity de-watering device 26 cfs.
Structure 19 - Capacity de-watering device 57 cfs.
Structure 21 - Capacity de-watering device 5 cfs.

3/ Structures: 1, 4, 7, 8 and 10 are designed on 6-hour duration, Antecedent Moisture Condition II.5.

$\frac{\text{AMC II} + \text{AMC III}}{2}$ = Antecedent Moisture Condition II.5.

4/ Capacity of low stage orifice calculated from crest of weir high stage inlet and capacity of single stage inlet calculated from crest of emergency spillway.

5,L-21,313

Date: April 1965

TABLE 3A - STRUCTURE DATA - CHANNELS

Mill Creek Watershed, Indiana

Channel Designation	Reach	Sta.	to Sta.	Watershed Area Sq.Mi.	1/ Types Impro.	Design Peak Flow c.f.s.	"n" Value	Average Hydr. Gradient Ft./Ft.	Average Bottom Grade Ft./Ft.	Average Channel Area Sq.Ft.	Avg. Depth Ft.	Avg. Bottom Width Ft.	Avg. Side Slope	Average Vel. in Channel Ft./Sec.	Planned Channel Cap. c.f.s.	Vol. of Exc. 1000 Cu.Yds.
Mill Creek Main	DD	1804+00	1751+77	250.6	CE&SR	4010	0.03	2/ .00098	.0001		2/ 7.5	100			4010	6/ 226
		1751+77	1607+50	250.6	CE&SR	4010		.00025			10.7	3/ 100		2/ 3.66	4010	
		1607+50	1596+70	243.0	CE	4020		.0002		1105	12.0	75	1.5:1	3.37	4020	
		1596+70	1533+11	241.9		4112		.00028		1220	12.6	75		3.12	4112	258
	DD	1533+11	1486+50	218.0		4300		.00016		1379	13.5	75		3.12	4300	
	CC	1486+50	1420+10	218.0		4300		.00016	.0001	1379	13.5	75		3.12	4300	
		1420+10	1401+60	218.0		4300		.00014	.00038	1379	13.5	3/ 75		3.12	4300	6a/654
		1401+60	1357+94	212.9		4115		.0002		1422	13.0	4/ 75		2.89	4115	
	CC	1357+94	1307+00	196.3		3886		.00023		1171	11.6	75		3.32	3886	
	Z	1307+00	1246+06	196.3		3886		.00023		1171	11.6	75		3.32	3886	
	Z	1246+06	1208+80	167.35		4686		.00044		1068	11.0	75		4.39	4686	386
	X	1208+80	1177+40	167.35		4686		.00044		1068	11.0	75		4.39	4686	111
	V	1177+40	1124+70	167.35		4686		.00044		1068	11.0	75		4.39	4686	216
	Q	1124+70	1123+85	167.35		4686		.00044		1068	11.0	4/ 75		4.39	4686	
		1123+85	1058+70	121.76		3835		.0004	.00038	931	11.35	65		4.12	3835	434
	Q	1058+70	973+70	121.76		3835		2/ .00064	.00078	811	10.67	60		2/ 4.73	3835	
	K	973+70	951+02	85.40	CE	2391	0.03	2/ .00078			2/ 10.1	5/	1.5:1		2391	18
		951+02	897+50	71.81	CS&SR	1975	0.035	.00078			10.1					
	K	897+50	887+00	65.84	CS&SR	1876	0.035	.00078			10.1					
	I	887+00	732+10	56.63	CS	1699	0.04	.00078			10.0					
		732+10	681+10	55.12		1653	0.04	.00078	.00078		10.0					
		681+10	598+00	55.12		1653	0.045	.0012	.0012		8.0					
	I	598+00	582+90		CS	1653	0.045	.002	.002		7.0					
Higgins Branch	BB	400+00	380+00	5.75	CS	430	0.05	.001								
		380+00	375+25		CS&SR	430	0.05	.001								
		375+25	330+00		CS&SR	430	0.05	.0018								
	BB	330+00	295+25	5.75	CS	430	0.05	.0018								
Cotton Branch	L	300+00	265+00	10.34	CE	1100	0.03	.0002	.0002	451	9.3	30	2:1	2/ 2.44	1100	48
		265+00	234+30	5.34	CE	540	0.03	2/ .0002	.0002	273	2/ 6.3	30	2:1	2/ 1.98	540	36
		234+30	183+30	4.92	CE	450	0.03	2/ .0015	.0015	192	2/ 6.3	20	2:1	2/ 2.34	540	34
		183+30	83+30	3.50	CS	271	0.045	.0028								
Bell Union	L	300+00	292+10	6.52	CS	650	0.045	.0017								
Old Mill Creek	J	300+00	205+00	5.63	CS	635	0.05	.0008								
Sallust Branch		200+00	125+60	5.63	CS	590	0.05	.0018								
	J	125+60	116+90	5.63	CS	590	0.05	.0035								
Mud Creek	P	700+00	650+50	36.18	CE	2668	0.03	.0004	.0004	689	9.9	45	2.5:1	3.57	2728	69
		650+50	612+50	34.20		2668		.0004	.0004	689	9.9	45		3.57	2728	
		612+50	565+20	33.54		2633		.0004	.0004	689	9.9	45		3.57	2728	219
		565+20	519+20	32.40	CE	2592	0.03	.0008	.0008	557	9.0	40	2.5:1	4.64	2585	

TABLE 3A - STRUCTURE DATA - CHANNELS

Mill Creek Watershed, Indiana

Channel Designation	Reach	Sta. to Sta.		Watershed Area Sq.Mi.	1/ Types Impro.	Design Peak Flow c.f.s.	"n" Value	Average Hydr. Gradient Ft./Ft.	Average Bottom Grade Ft./Ft.	Average Channel Area Sq.Ft.	Avg. Depth Ft.	Avg. Bottom Width Ft.	Avg. Side Slope	Average Vel. in Channel Ft./Sec.	Planned Channel Cap. c.f.s.	Vol. of Exc. 1000 Cu.Yds.
Mud Creek		519+20	495+70	30.53	CE	2473	0.03	.0008	.0008	557	9.0	40	2.5:1	4.64	2585	
		495+70	473+70	29.25	↑	2413	↑	↑	↑	557	9.0	40	↑	4.64	2585	
		473+70	458+30	27.76	↓	2360	↓	↓	↓	515	8.5	40	↓	4.50	2320	114
		458+30	423+30	26.70		2291				515	8.5	40		4.50	2320	
		423+30	404+30	25.25		2222		.0008	.0008	515	8.5	40		4.50	2320	
	P	404+30	394+30	17.50	CE	1540	0.03	.0006	.0006	435	7.5	40	2.5:1	3.68	1600	
Lake Ditch	U	650+00	628+00	40.4	CE	2020	0.03	.0002	.0002	745	10.5	50	2:1	2.71	2020	
		628+00	603+50	39.85	↑	1992	↑			745	10.5	50	↑	2.71	2020	
		603+50	565+75	37.52		1989				745	10.5	50		2.71	2020	
		565+75	533+25	36.97		1996		.0002	.0002	745	10.5	50		2.71	2020	
		533+25	530+25	35.48		1951		.0003	.0003	633	9.8	45		3.08	1951	
		530+25	501+00	34.59		1699		↑	↑	567	9.0	45		2.99	1699	
		501+00	450+34	33.90		1678				567	9.0	45		2.99	1699	569
		450+34	434+00	33.48		1657				543	8.7	45		3.05	1657	
		434+00	407+20	31.48		1605				543	8.7	45		3.05	1657	
		407+20	381+20	28.27		1498				511	8.3	45		2.93	1498	
		381+20	377+20	27.34		1463				503	8.2	45		2.90	1463	
		377+20	355+20	26.24		1430				488	8.0	45		2.84	1385	
	U	355+20	347+20	23.89		1338		.0003	.0003	488	8.0	45		2.84	1385	
	T	347+20	341+20	16.0		1016		.0006	.0006	304	8.0	22		3.34	1016	
		341+20	319+10	15.5		992		↑	↑	304	8.0	22		3.34	1016	
		319+10	268+60	14.0		924				272	8.0	18		3.39	922	
		268+60	245+66	14.0		924				272	8.0	18		3.39	922	61
		245+66	232+66	13.0		877				272	8.0	18		3.39	922	
		232+66	226+60	12.0	↓	828	↓	.0006	.0006	272	8.0	18	↓	3.39	922	
	T	226+60	194+35	8.0	CE	616	0.03	.0002	.0002	288	8.0	20	2:1	2.13	616	
Rhodes Creek	W	600+00	523+00	20.59	CE	800	0.03	.0006	.0006	234	7.5	20	1.5:1	3.50	819	27
		523+00	421+80	20.59	CE	800	0.03	.0006	.0006	234	7.5	20	↑	3.50	819	
		421+80	363+80	19.82	CE	740	0.03	.0006	.0006	234	7.5	20		3.50	819	78
		363+80	277+80	15.22	CS&SR	740	0.04	.0016	.0016	189	7.5	14		3.91	740	
	W	277+80	273+80	8.65	CS&SR	740	0.04	.0016	.0016	189	7.5	14	↓	3.91	740	

1/ Types of Improvement may be: (a) Channel Excavation - (CE); (b) Clearing, Snagging - (CS); (c) Shoal Removal-(SR)

2/ Hydraulic gradient velocities and depth vary due to backwater; values shown are averages between the stations shown.

3/ Indicates berms set at 12 feet.

4/ Indicates berms set at 10 feet

5/ Transition from 60 ft. bottom width to 30 ft. bottom width.

6/ 17,500 cu.yd. - (6a) 4,833 cu.yds. - Rock Excavation.

Date: April 1965

USDA-SCS-LINCOLN, NEBR. 1968

TABLE 4 - ANNUAL COST

Mill Creek Watershed, Indiana

(Dollars) 1/

Evaluation Unit (1)	Amortization of Installation Cost 2/ (2)	Operation & Maintenance Cost 3/ (3)	Total (4)
All Structural Measures	196,956	49,284	246,240
TOTAL	196,956	49,284	246,240

1/ Price base - 1964 for installation costs and projected long-term for O&M and Other Economic Costs.

2/ 3-1/8% - 50-year amortization period

3/ O&M cost for Basic Facilities amount to $8925 for Structure #9.

Date: April 1965

USDA-SCS-LINCOLN, NEBR. 1965

TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

Mill Creek Watershed, Indiana

(Dollars) 1/

ITEM (1)	Estimated Average Annual Damage		Damage Reduction Benefits (4)
	Without Project (2)	With Project (3)	
Floodwater			
Crop and Pasture	318,978	90,836	228,142
Other Agriculture	18,600	5,300	13,300
Subtotal	337,578	96,136	241,442
Indirect	33,758	9,614	24,144
TOTAL	371,336	105,750	265,586

1/ Price base - Projected Long Term

Date: April 1965

TABLE 6 - COMPARISON OF BENEFITS AND COST FOR STRUCTURAL MEASURES

Mill Creek Watershed, Indiana

(Dollars) 1/

Evaluation Unit (1)	AVERAGE ANNUAL BENEFITS							Average Annual Cost (9)	Benefit Cost Ratio (10)
	Flood Prevention			Recreation		Secondary (7)	Total (8)		
	Damage Reduction (2)	More Intensive Land Use (3)	Saving In Bridge Cost (4)	Development (5)	Incidental (6)				
All Reaches	252,306	49,140	5,110	38,758	2,161	40,560	388,035		
TOTAL	252,306 2/	49,140	5,110	38,758	2,161	40,560	388,035	246,240	1.6:1.0

1/ Price base - Projected long term for benefits and for O&M and other economic costs; and 1964 for installation costs.

2/ In addition, it is estimated that land treatment measures will provide flood damage reduction benefits of $13,280 annually.

Date: April 1965

INVESTIGATIONS AND ANALYSES

INVESTIGATIONS AND ANALAYSES

This section describes the type and intensity of the investigations and analyses which were made in formulating and evaluating the project. It describes the scope and intensity of surveys and investigations, and the methods used in analyzing and interpreting the basic watershed data in order to determine the physical and economic feasibility of the project. The material is presented under the following appropriate headings.

HYDROLOGY AND HYDRAULICS

The following steps and procedures were used in the hydraulic and hydrologic investigations to ascertain physical data for the economic evaluation and design of these proposed watershed works of improvement.

Because of the size of the watershed and the need for designs and evaluations by tributaries, rainfall data was used for project design and evaluations. The U. S. Weather Bureau Technical Paper 40, "Rainfall Frequency Atlas of the United States" was used to determine the rainfall frequency array. There is one recording rainfall gauge within the watershed. The gauge is located at Eminence with a period of record of 10 years and its record has been integrated into the TP-40 frequency studies by the U. S. Weather Bureau.

The land use as indicated by the County Conservation Needs data for each land resource area in the watershed was tabulated, verified and adjusted for existing and future land treatment by the Forest Service and the Work Unit Conservationist. From this information the hydrologist determined the present and future land treatment curve number by major tributary acres. Future land treatment was used in the determination of the channel design and present condition for floodwater retarding structure design hydrology. The future soil cover complex number for the watershed was developed by assuming the land treatment measures installed during the installation period of this project.

Runoff determined from the 6-hour cropping season rainfall and curve number relationship was used for the tributary evaluations and design. Area corrected cropping season 6-hour duration rainfall-runoff volume and resulting peak flow was used for the design of the main in its evaluation.

The design runoff curve number for each structure as indicated in Table 3, was developed for present land use by evaluating the hydrologic soil cover complexes in the watershed above each site. The curve number for structures should be checked at construction if the sediment rate changes. The runoff for the design frequency for the principal spillway design was obtained directly from 6-hour rainfall values in TP-40 and the use of Antecedent Moisture Condition II.5. All floodwater retarding structures were checked according to the method in SCS TR-#10 using Moisture Condition II. The hydrologic criteria for the emergency spillway and freeboard design were taken from rainfall maps prepared by the Soil Conservation Service adapted from U. S. Weather Bureau information in TP-40. These design data are shown in Table 3.

The Wilson Method of Graphical Flood Routing was used to route a storm of uniform one (1) inch of runoff from a six-hour duration rainfall occurrence. In addition, long duration storms were checked under present condition to compare peak discharges and area flooded. It was determined form this analysis that the 6-hour duration storm would be used for damage appraisal, with a cropping season adjustment based on drainage area.

Triangular hydrographs were developed based on time of concentration for each subwatershed. These hydrographs were routed and accumulated down the main stem and tributaries through the routing reaches.

The peak discharge was determined at the foot of each routing reach by Wilson graphic method of routing. The peak rates of discharge at intermediate cross sections within the routing reaches were interpolated by logarithmic relationship between drainage area and rate of discharge using the concordant flow principle.

Stage area inundated tables by 0-2 feet depth and over 2 feet depths were prepared for each evaluation reach. This information was then co-ordinated with stage discharge and discharge-frequency curves for the economic evaluation.

Area inundated, as reflected by the selected valley cross sections, was adjusted to actual area based upon field observation, interviews and aerial photographs.

All channel designs are based on 6-hour cropping season 3-year frequency design. A minimum of 3-year level of protection is provided to all reaches except DD of the main channel. No increased stages are expected in this reach.

The increased peak flows due to the designed channel improvement are not expected to affect the U. S. Corps of Engineers' Cagles Mill Flood Control Dam operations.

Engineering

Evaluation studies of this project were made using several different trials and combinations of channel improvement and floodwater retarding structures.

The basic data used was obtained from U. S. Geological Survey topographic maps, serial photographs, field surveys and field observations. All field surveys are based on mean sea level datum.

Floodwater Retarding Structures

State storage and stage area curves were developed from USGS $7\frac{1}{2}$' topographic maps. Field surveys were made along the centerline of the fill of each proposed structure with at least one or two cross sections in the pool area. These surveys were used to check and adjust, if necessary, the state storage and stage area curves. Also the centerline cross sections were used in the computation of earth embankment yardage. Elevations of critical points, such as roads, houses, cemeteries and public utilities were determined by field surveys.

The structures were designed to meet the criteria contained in SCS Engineering Memorandum No. 27, other applicable SCS Engineering Memoranda, and the design standards of the Indiana Department of Natural Resources.

The requirements for sediment storage as estimated by the geologist were used to set the elevation of the principal spillway, except the two multipurpose structures.

The crest of the emergency spillway was set by flood routing a 50-year frequency storm. Either a 6-hour duration rainfall using Antededent Moisture Condition $II\frac{1}{2}$ or the procedure given by SCS Technical Release No. 10 using longer duration storm and antecedent moisture condition II was used for the principal spillway hydrograph. The principal spillway release rates were determined by the downstream channel capacities, the timing of the structures, and the desired level of protection.

The dimensions of the emergency spillway and the elevation of the top of the dam were based upon the flood routing of the freeboard hydrograph. The capacity of the emergency spillway was determined by the procedures set forth in SCS Technical Release No. 2 and Supplement A. Considered in the economics of the structure sites were the amount of embankment material, amounts of excavation of emergency spillway, elevations of roads, buildings, cemeteries, pipelines and public utilities.

The preliminary geologic investigation report was used as a guide to determine embankment and foundation design, and to estimate fill side slopes, core trench dimensions and drainage requirements for each structure site.

Channel Improvement

The channels were designed and evaluated using the three-year and five-year cropping season peak flows.

The main channel below Mud Ditch was programmed for the I.B.M. 650 computer for water surface profile development.

The SCS National Engineering Handbook, Section 16 was used for the selection of Manning's "n", side slopes, berm widths and permissible velocities. The procedure for Hydraulic Design of Bridges, Section XIII, page 2.05, Indiana Engineers Handbook, was used in calculating bridge losses on the tributaries.

The hydraulic gradient was set on the tributary flood prevention channels, using the water surface profiles calculated on the main, as a control point.

Bridge Nos. 3, 4, 5 and 13 on Mill Creek and No. 1 on Lake Ditch were considered for underpinning.

The berm and inside of the spoil of all channel works of improvement will be seeded to control erosion and improve farm game wildlife habitat except for about $5\frac{1}{2}$ miles as noted in the following paragraphs.

The channel design data is summarized on Table 3A for the main and tributaries.

No channel improvement was planned on the following tributaries: Sand Branch; Vermillion Branch, Reach Y; Coatsville Branch, Reaches H and F; Crittenden Creek, Reach B; Upper Mill Creek, Reaches A and C; East For Mill Creek and Brush Creek. Grading back will be done where needed.

Reaches in which channel improvement were planned are discussed under the following channel headings:

Mill Creek - Reaches I, K, Q, V, X, Z, CC, DD - The main channel was designed to contain within banks a 3-year cropping season flow. The planned works of improvement consist of channel excavation, and shoal removal with selective bank clearing to maintain the existing recreational sites.

Beginning at Upper Cataract Falls station 1804+00 to Highway 43 station 1607+70, the natural existing channel varies in bottom width from 110 feet to less than 75 feet. Also the channel bottom varies from sand and gravel, smooth bedrock to a massive rock (limestone) overfalls, with holes from 300 feet to 600 feet in length and depths of 6 to 10 feet. These holes exist in the bedrock formation.

The high wooded banks of this section of channel are scenic with elevations as much as 50 to 150 feet above the stream.

The massive bedrock control section at Upper Cataract Falls, will continue the hydraulic gradient and maintain the natural water level of the existing deep holes.

In the area where the natural channel is less than 100 feet wide, channel excavation is planned to increase the bottom width to 100 feet with side slopes of 1.5 to 1. This work will be done on the flood plain side of the channel. The minimum amount of clearing needed is not expected to adversely affect fish and wildlife populations.

Income producing recreation enterprises are established in 4 to 6 locations along this section of Mill Creek. The potential of developing more recreational enterprises will be improved because of reduced flood hazard.

Channel alignment is planned at the following locations: 1), curve about 500 feet in length in the NE 1/4 of the SW 1/4 section 31; 2), curve and falls about 750 feet in length in the NW 1/4 of the SW 1/4 section 32; 3), curve about 400 feet in length in the SW 1/4 of the NW 1/4 section 32; and 4), two curves about 1000 feet in length in the NE 1/4 of the SE 1/4 section 32, or approximately 300 feet downstream from State Highway 43, T12N R3W. No appurtenances are planned downstream from Highway 43.

Beginning at station 1607+70 or Highway 43 channel excavation is planned with side slopes of 1.5 to 1. The maximum constructed berm height is set at 12 feet above the channel bottom between Highway 43 station 1607+70 and the Monon Railroad station 1401+60. A maximum berm height is set at 10 feet above the constructed channel bottom between the Monon Railroad station 1401+60 and station 1123+85 or 100 feet upstream from junction of Lake Ditch. A berm width of 30 feet is planned, with the spoil bank having 3:1 side slopes on the channel side and 4:1 side slopes or flatter on the field side.

When the maximum constructed berm height of 10 or 12 feet exceeds the normal ground in height or elevation, the berms may be installed at the normal ground elevation. The construction of the spoil banks should maintain the same alignment, design and elevation. Example, if the normal ground is one foot below the planned berm height subtract three feet from the planned 30 foot berm to start construction of the spoil bank. A continuous spoil is planned beginning at station 1607+70 or Highway 43 and continues upstream tapering out at station 1308+30 or Highway 42. The continous spoil will contain the 3-year cropping season peak flow. Spillway openings will be constructed at the 3-year cropping season hydraulic gradient, to provide passage of flows greater than the 3-year cropping season peak. These spillways will allow use of floodplain storage for storms in excess of design. Re-entrance of this storage will be provided by constructed surface drains in the floodplain and free flow appurtenances at natural entrances.

The berm and inside of spoil of these reaches will be seeded to sod forming grass and mown to maintain the flood flow capacity. The top and field side of spoil will be seeded to herbaceous materials to improve wildlife habitat for farm game species where possible.

Channel excavation ends at station 951+02 or approximately 300 feet upstream from the junction of Cotton Branch.

Clearing, snagging and shoal removal is planned from station 951+02 to station 887+00, with clearing and snagging only from station 887+00 to station 582+90. Openings will be placed in the existing spoil bank between station 951+02 and station 681+10 or Highway 40. These openings using emergency spillway design, with the crest elevation set at low ground, will be located on each side of channel about 1/4 mile apart to provide storage, and thus reduce peak flow of events greater than the 3-year cropping season frequency. This is necessary to reduce induced damages on downstream channel reaches.

Critical depth for the 3-year cropping season peak discharges was used at the control section of Upper Cataract Falls or station 1804+00, to set the elevation of the water surface to proceed upstream with water surface profiles. From Upper Cataract Falls (station 1804+00) to station 969+80, the 3-year cropping season peak flows were calculated using SCS Technical Release No. 15 to determine water surface profiles and related parameters.

Design water surface elevations at critical points along the main channel are listed as follows:

Station	Water Surface Elevation MSL
1804+00 Cataract Falls	711.60
1607+50 Highway 43	720.00
1401+60 Monon Railroad	724.20
1308+30 Highway 42	725.80
1245+80 Bridge #9	727.40
1124+70 Lake Ditch Junction	732.70
1058+70	735.30
973+70 Mud Creek Junction	740.70

The hydraulic grade line elevations derived from the water surface profile calculations, indicate a free outlet will exist for the tributaries during 3-year cropping season flow. Several alternate designs were tried using various hydraulic grade lines and bottom widths. The design selected provided the most practical solution to the problem of this watershed.

The hydraulic designs of the bridge on the main channel were programed according to SCS Technical Release No. 14, using the I.B.M. 650 computer to calculate the head losses for the bridges.

Provisions were made for side water entering the main channel between station 1307+30 and station 681+10, using an average of eight appurtenances per mile. Collection ditches behind the spoil were considered as part of the design of the appurtenances.

Higgins Branch - Reach BB - The planned works of improvement are clearing, snagging and shoal removal beginning at the junction with Mill Creek (station 400+00), and ending at station 295+25 or at the junction of the tributary on which structure No. 1 is located. No appurtenances are planned for this reach.

Cotton Branch - Reach L - The channel is designed to contain the 3-year cropping season peak flow, beginning at the outlet at Mill Creek (station 300+00) to station 183+30. Provisions were made for side water to enter the channel on this portion of the reach by an average of eight appurtenances per mile. Collection ditches behind the spoil were considered as part of the design of the appurtenances. Clearing and snagging is planned from station 183+30 to station 83+30, or the junction of the tributary on which structure No. 4 is located. No appurtenances are planned on this portion of the reach.

Bell Union - Reach L - The planned work consists of approximately 800 feet of clearing and snagging, upstream from the junction with Cotton Branch. Due to the restrictive concrete arch bridge upstream and lack of structural control, a 3-year cropping season level of protection could not be provided upstream from the proposed clearing and snagging.

Old Mill Creek and Sallust Branch - Reach J - The planned work is clearing and snagging beginning at junction of Mill Creek (station 300+00) to station 205+00 (Sallust Branch). On Sallust Branch the planned work is clearing and snagging beginning at the junction with Old Mill Creek (station 200+00) to station 116+90 or the bridge upstream from the junction of the tributary on which structure No. 6 is located. No appurtenances are planned on this reach.

Mud Creek - Reach P - A designed channel is planned with sufficient capacity to contain within bank a 3-year cropping season peak flow, beginning at the junction with Mill Creek (station 700+00) to station 394+00 or approximately 1,000 feet upstream from bridge No. 4, which is the first bridge located upstream from the Hendricks-Morgan County Line.

The channel was designed by use of Manning's formula using side slopes of $2\frac{1}{2}$:1 and bottom widths of 40-45 feet. The lower 3-feet of the channel banks are poorly graded sand. Beginning at station 566+70 to station 394+40 fifteen (15) grade stabilization sills are planned, and will raise the bottom grade from one (1) to two (2) feet at each sill. These sills are interlocking sheet steel piling driven in two (2) rows across the channel and banks, with the sheet steel cut parallel to the bank side slopes. Riprap of a designed size will be placed between the two (2) rows of sheet steel. The banks and bottom will be riprapped 25 feet downstream. The banks will be riprapped 25 feet upstream. These sills were planned with not less than one (1) foot of tail water backing up to each sill, leaving approximately one (1) foot of overfall.

A berm width of 20 feet was planned, located at the existing ground line. Provisions were made for side water to enter channel by an average of eight appurtenances per mile. Collection ditches behind the spoil were considered as part of the design of the appurtenances.

Several alternate designswere tried using various hydraulic gradients, grade stabilization structures, dumped riprap side slopes and bottom widths. The design selected provides the most practical and economical solution to the problem on Mud Creek.

Bridge No. 1, station 612+50 will be riprapped through the transition area of a 45 foot bottom to the 37 foot bottom available under the bridge. This bridge has poured concrete side slopes. Bridges No. 2 at station 519+20 and No. 3 at station 473+70 will be replaced as non-project cost. These bridges have served their useful life.

The Sponsoring Local Organization should give consideration to continuing work upstream from station 394+00, using grade stabilization problem and maintenance cost.

Lake Ditch - Reaches U and T - A designed channel is planned with sufficient capacity to contain within bank a 3-year cropping season peak flow beginning at the junction with Mill Creek (station 650+00) to station 194+35 which is the junction of the tributary entering from the east in section 16 T13N, R1W.

By opening the restriction at station 268+60 from approximately a "C" drainage curve to a 3-year cropping season peak increased the demands on Lake Ditch. The channel was designed limiting the depth, increasing the bottom width, using side slopes of 2:1 and berms of 20 feet. Limiting depth helps to decrease the degrading problem of the tributaries entering Lake Ditch.

Lake Ditch follows the present alignment except through Bridge No. 1 located at station 585+00, the two steep hills on the south bank between station 585+00 and station 533+25 (Highway 42), and station 268+60 (bridge No. 6). The re-alignment of the channel in these areas will facilitate flow through the bridges and reduce the bank sloughing. Provisions were made for side water to enter the channel by an average of 10 appurtenances and two structures per mile. Collection ditches behind the spoil were considered as part of the design of the appurtenances.

Several alternate designs were studied using various hydraulic gradients, bottom widths, and side slopes. The design selected provided the most practical solution to the problem.

Bridge No. 6 at station 268+60 will be replaced and re-located over the re-aligned Lake Ditch as non-project cost. The bridge has served its useful life.

Rhodes Creek - Reach W - The channel is designed to contain within bank a 3-year cropping season peak flow. Beginning at the junction with Mill Creek (station 600+00) to structure site No. 19, the planned works of improvement include channel re-alignment, excavation, clearing, snagging and shoal removal. The channel re-alignment is planned between station 600+00 to station 590+00 and station 437+30 to station 428+30 (Highway 42).

Provisions were made for side water on cropland to enter the channel between the following stations:

Beginning at station 600+00	-	ending at station 566+00
Beginning at station 523+00	-	ending at station 488+00
Beginning at station 448+00	-	ending at station 358+90

Collection ditches behind the spoil were considered as part of the design of appurtenances by an average of eight appurtenances per mile.

Geology

Aerial photographs were used for sterescopic studies of the proposed floodwater retarding structures and channel improvement areas. Topographic maps and photographs were used during subsequent field studies. Various geology publications and maps by the Indiana Department of Natural Resources, Geological Survey, were used for information on glacial deposits and stratigraphy.

Floodwater Retarding Structures

Floodwater retarding structure sites were examined by surface observations and hand auger borings to determine physical characteristics and extent of potential design problems. Favorable foundation conditions were found at all sites. The channels at all structures contain modern sediment deposits of silt, sand and gravel, and the valleys have recent alluvial deposits over glacial materials. Structures No. 20, 21 and 22 are located essentially on glacial till with little alluvial deposition. Bedrock outcrops occur in the lower reaches of the watershed, but no rock was found at any structure sites. No rock excavation is expected at dam site centerlines and emergency spillways. Well consolidated, essentially impervous materials were found six to ten feet below the valley flood at all sites. Erosion in emergency spillways may be a problem where deep cuts are concerned.

Borrow areas were bored by hand auger to determine quality and available depth. Suitable borrow can be obtained from the pool area and adjacent slopes of structures No. 3, 6, 7, 8, 18, 20, 21 and 22. Borrow of acceptable quality can be found on the slopes and hill tops surrounding the pool areas of structures No. 1, 2, 4, 9, 10 and 19. Excavated material from emergency spillways of all structures can be used for fill purposes.

Detailed subsurface investigations will be conducted at each site during the operations stage to insure structural stability. In addition, studies of structures No. 3 and 9 (multipurpose recreation) will be sufficient to provide adequate design data needed to insure that the structures function as planned. Disturbed samples of foundation and borrow materials will be taken for necessary laboratory tests. Undisturbed samples will be taken of all questionable foundation material, and standard penetration tests will be conducted as needed during drilling operations. Cost estimates for further geologic investigations were derived from past cost records for similar sites.

Sediment Storage Requirements

Sediment storage requirements for each structure were estimated according to SCS Engineering Memo No. 16 and SCS Technical Release No. 12. Sediment deposition at each structure from sheet and other types of erosion was determined by the volume voided and delivered per year. Delivery rates were estimated and applied according to topography (stream density, gradient, channel size, and length), watershed area, sediment source and sediment texture. Present land use, soils, and slopes by capability sub-classes within State Resource Areas, were obtained from Conservation Needs data from each county involved, then adjusted to the watershed size. Expected changes during project installation were estimated by local Service technicians with assistance from farmers involved.

The Universal Equation, with data compiled for Indiana, was applied to two representative structures as a check on the present method of estimating sediment storage. The results did not compare favorably. Since the Conservation Needs data represents approximately a two percent sample, a margin of error is possible concerning land use behind a particular structure. Therefore, it is recommended that the sediment storage as shown in Table 3 be reviewed on an individual structure basis prior to final design.

Channels

Preliminary channel investigations consisted of hand auger borings to determine soil conditions of the channel bed and banks, and probings to locate possible rock excavation along the proposed channel improvement area. The channel banks along Mill Creek are fairly stable silty clays, sandy clays, and clayey silts. The channel bottom has deposits of silty sand, sand and fine gravel, with gravel content decreasing downstream. Present levees and spoil banks along Mill Creek are high in sand content, indicating a probable cause of levee breaks during floods. Mud Creek and Lake Ditch channels have fairly stable silty to sandy clays in the upper portion of their banks. A sand layer was found near the channel bottom in the lower reaches of both channels. This sand lense with heavy spoil banks and associated water seepage creates a continuously unstable condition. Bank sloughing contributes heavily to channel filling with sand deposits. A fairly tight sandy clay material underlies the sand layer. By offsetting the spoil banks, thereby relieving abnormal pressures, this unstable condition will be partically alleviated with project.

The only rock encountered by structural measures will be in lower Mill Creek channel below Indiana Highway No. 42. Thin-bedded, low grade limestone will be excavated near two bridges between Indiana Highways No. 42 and No. 43. Massive limestone will be intermittently removed from the channel bottom between Highway No. 43 and Upper Cataract Falls. Design cost estimates provide for this rock removal.

Detailed geologic investigations, consisting of adequate borings along the proposed channel excavation, and necessary foundation investigation at proposed grade control structures, will be made prior to final design. Necessary tests and sampling will be conducted during the investigation as needed to acquire necessary design data.

Erosion and Sedimentation

Bottomland damage areas, potentially critical upland erosion areas, and streambank erosion points were located by the study of aerial photographs. These locations were then investigated in the field to determine actual degree and extent of damage. History and effect on agricultural production were determined through interview and photo comparison. References used for soil conditions and occurrence were the Putnam County and Hendricks County Soil survey reports. Land Use and soil type information were obtained from the Conservation Needs data and the local Service technicians' knowledge of the watershed.

Upland sheet erosion was estimated using the Conservation Needs data as adjusted by the local Service technicians. Sheet erosion is not severe. Planned land treatment measures and their continued practice after installation will aid in erosion control. Scour damage was not evaluated due to subjection to future flooding. Infertile overwash was studied according to the Cornbelt Handbook Procedures No. 250 and No. 650. Damages revealed from this study were insignificant.

Sediment damage due to channel filling was evaluated on Lake Ditch only, because other channels with structural control do not have past cleanout cost records, and the damage is not severe. Lake Ditch was evaluated using Cornbelt Handbook Procedures No. 260 and No. 660. Cleanout records were obtained from local officials and contractors involved. Benefits derived from Lake Ditch sediment damage reduction are not significant to the overall project.

ECONOMICS

Floodwater Damage

Crop and Pasture - The procedure used for study is based upon damage resulting from the one largest flood in each year with an adjustment factor of 15% for the most damaging flood each year. A composite acre technique of evaluation was used. Damage schedules were developed by months for the different crops and weighted by the percent of monthly flood distribution. The average annual damage per acre of crop flooded for area I and II was determined.

The composite acre and flood free yield used are as follows:

Area I - Reaches A, B, C, F, H, I, J, K, L, Q, V, W, X, Y, Z, AA, BB, CC, and DD:

Crop	Yield/Acre	Percent
Corn	85 bushels	44
Soybeans	30 bushels	18
Wheat	30 bushels	7
Meadow	3 tons	4
Pasture	50 CPD	10
Woods		12
Misc. and Idle		5

Area II - Reaches P, R, S, T, U, O:

Crop	Yield/Acre	Percent
Corn	90 bushels	49
Soybeans	35 bushels	20
Wheat	35 bushels	8
Meadow	3 tons	4
Pasture	75 CPD	10
Woods		2
Misc. and Idle		7

Acres were compiled on a stage area flooded curve. The average annual damage figure per acre, based on the above composite acre for depths 0-2 feet and over two feet, was used to develop a stage damage curve for the reach. From peak discharge-frequency relationship, a flood damage versus frequency of occurrence graph was made. The average annual crop and pasture damage for each reach was then determined by planimetering the area under the curve and converting the area measurements into dollar damage according to the scale of the graph. The average annual benefits by reaches due to the works of improvement, was determined by subtracting the remaining damages with the project from the damage evaluation without the project. The area of cropland benefited in the reaches from the works of improvement is 14,366 acres.

Other Agricultural - The primary damage is to fences, buildings machinery and livestock. More detailed analysis of several similar watersheds show these damages to be $1.00 per acre inundated. Works of improvement will provide 72% damage reduction to the $18,600 damage. The benefits to other agriculture amounts to $13,300.

Non-Agricultural - The damage to roads and bridges was minor in the floodplain. Twelve affected bridges will be replaced in the next fifteen years. The difference of replacement value with project versus without project was considered a benefit. Benefits were discounted for the time lag to bridge replacement and then amortized to arrive at an average annual benefit. The saving in bridge costs with the project amounts to $5,110 annually.

Indirect - Re-routing of traffic and increased cost to carry out normal operations during flood periods are considered indirect damages. Indirect benefits are 10 percent of the total average annual floodwater benefits and are estimated at $24,144.

Benefits From More Intensive Land Use

Benefits from more intensive land use of present cropland within the floodplain were determined by interview of farmers and professional agricultural workers. More intensive land use benefits were computed on those cropland acres which presently are flooded by the 3-year frequency size flood. Benefits are based on future net income with flood protection at a 3-year level, as compared to present income.

Supporting Data On More Intensive Use of Floodplain Land - (MIU)

Area I

Without Project, Composite Acre Basis

Crop	Yield 1/	Net	Percent	Composite
Corn	85 bushels	79.11	60	47.47
Soybeans	30 bushels	44.59	25	11.15
Wheat	30 bushels	28.33	10	2.83
Hay	3 tons	13.92	5	.70
			Total	62.15

With Project, Composite Acre Basis

Crop	Yield 1/	Net	Percent	Composite
Corn	90 bushels	82.91	60	49.74
Soybeans	35 bushels	54.72	25	13.69
Wheat	35 bushels	34.80	10	3.49
Hay	3.5 tons	17.60	5	.88
			Total	67.80

Increase Net Return $5.65

Area II

Without Project, Composite Acre Basis

Crop	Yield 1/	Net	Percent	Composite
Corn	90 bushels	85.05	60	51.03
Soybeans	35 bushels	55.26	25	13.81
Wheat	35 bushels	35.25	10	3.53
Hay	3.5 tons	17.60	5	.88
			Total	69.55

With Project, Composite Acre Basis

Crop	Yield 1/	Net	Percent	Composite
Corn	95 bushels	88.85	60	53.31
Soybeans	40 bushels	65.39	25	16.35
Wheat	40 bushels	41.72	10	4.17
Hay	3.5 tons	17.60	5	.88
			Total	74.71

Increase Net Return $5.16

1/ Flood Free Yields

It was estimated that in Area I only 73% of acres flooding will have more intensive use benefits. In Area II only 81% will have more intensive use benefits. The total area benefited is 9,130 acres with the average annual benefit at $49,140.

Water Management

Planned Recreation - There are two multiple purpose structures in the watershed. Structure No. 3 will be used only for fishing. The number of fishermen was estimated at 100 per acre per year, or a total of 6,500 visitor days. The benefits were considered at 50¢ per day. The benefits were not lagged for a build-up period.

For structure No. 9 the recreation use will be fishing, boating, picnicking, camping and hiking. The visitor days for fishing is 100 per acre per year. All other was based on the population within a 25-mile radius. The visitor days were increased to account for the projected population for the next 15 years. The average increase for the past 20 years has been 2% per year, which was projected as 30% increase over the next 15 years. The benefits were calculated at $1.25 per visitor day and were lagged for a 5-year build-up period.

The basic facilities for structure No. 9 are listed in Table 2B. The economic life of 15 years were used for replacement of water supply, roads, flush toilets, showers and parking area. The grills and tables were figured to have an economic life of 5 years and boat docks a life of 10 years.

Incidental Recreation - The surface area of nine sediment pools in single purpose flood prevention reservoirs range from 5 to 48 acres and total 170 acres. To utilize these sites, associated costs will be incurred for access roads and other minimum facilities. It is estimated that a 10,800 visitor-day use will annually be made of the undeveloped and minimum facilities. Sediment accumulation will begin to detract from these areas after about 20 years. As the sediment continues to accumulate in these pools, the incidental recreational value declines to nothing at the end of 45 years. The $2,161 for incidental recreation was computed thusly:

120 visitor - days/surface acre/year @ $.50/visitor-day . . .	$60
Associated costs (access road, minimum facilities).	30
Incidental Recreation Benefits/Surface acres/year	$30
Discounted for sediment accumulation from 20 to 45th year	
Current value of incidental recreation/surface acre	$603.63
Incidental recreation benefits/surface acre (amor. @ 3-1/8% over 50 years).	24.01
Incidental recreation benefits on 90 of the 170 acres @ $24.01.	$2161.00

Secondary

Ten percent of the value of the direct primary benefits and the value of the increased costs that primary producers will incur were considered local secondary benefits. Thus, local secondary benefits induced by the project are $33,353 and stemming from the project are $7,207.

Cost Allocation

For structures No. 3 and 9 the use of facilities method was used for cost allocation.

The following tables show the allocated costs:

Structure #3	Multiple Purpose	Flood Prevention	Recreation
Storage (Ac.Ft.)	1,359	1,039	320
Facilities Allocation %	100	76.5	23.5
Construction	$95,800	$73,285	$22,515
Installation Services	36,500	27,923	8,577
Administration of Contract	2,900	2,219	681
Land, Easement & RW	39,000	29,835	9,165
TOTAL	$174,200	$133,262	$40,938

Other funds will pay construction cost, all land, easement and rights-of-way, administration of contracts, as well as installation services allocated to recreation.

Structure #9	Multiple Purpose	Flood Prevention	Recreation
Storage (Ac.Ft.)	2,400	1,025	1,375
Facilities Allocation %	100	42.7	57.3
Construction	$123,970	$52,934	$ 71,036
Installation Services	47,110	20,116	26,994
Administration of Contract	1,700	726	974
Land, Easements & R/W	100,000	1,400	98,600
Basic Facilities			
Construction	65,000		65,000
Installation Services	7,500		7,500
Adminis. of Contracts	2,500		2,500
Land, Easements & R/W	100,100		100,100
TOTAL	$447,880	$75,176	$372,704

PL-566 cost-shares on 50% of construction allocated to recreation. For land, easement and R/W, PL-566 cost share is 50% of cost allocated to recreation or 29.2% for the total area, plus 50% for construction of basic facilities.

Prices and Interest Rates

Prices used in this report were projected long-term prices for evaluating damages and benefits. For converting public investment to an annual basis, and for discounting benefits to reflect the anticipated lag in accrual, three and one-eighth percent (3-1/8%) interest rate was used.

The estimated costs used for land, easements and rights-of-way were determined by the Local Sponsoring Organization, County Commissioners, Public Utilities and the Soil Conservation Service.

Land costs for structures average $200 per acre for all areas between valley floor and 2feet above crest elevation of low stage or single inlets, and $100 per acre for all areas between that elevation and 2 feet above crest of emergency spillway, depending on location and use being made. The higher figure was used for cropland that would be required on a continuing basis, and the lower figure was used for land required for use during construction of project.

BIOLOGY

Studies and investigations were conducted in order to provide improvement to fish and wildlife habitat with considerable stress on possible negative effect from channel improvement and enlargement. Of the total 25.6 miles of stream under consideration, less than 21.9 miles are sufficient size to support a sport fishing. Approximately 11.4 miles of the upstream portion of the 21.9 miles appear to have been extensively straightedned and dredged. These changes destroyed the desirable poolriffle and meandering characteristics of the stream creating a highly unsuitable habitat for most sport fishes. It appears that out of a total stream length of 25.6 miles only about 10.5 miles or less of stream could be utilized as a sport fishery.

A field study by Soil Conservation Service and Indiana Department of Natural Resources biologists was conducted in Reach DD between the Upper Cataract Falls and Highways Indiana 43 and U. S. 231. Within this reach there is now a significant fishery resource. The present fish population was inventoried by use of a shocker boat study and channel bottom profiles considered to determine "fishing holes" now in existence.

It was determined that the present fish population and distribution of desirable fish is good. Further and more detailed studies will be required before specific recommendations for improvement could be developed. At this time, for example, it seems illogical to kill a potentially good bass population to control a small carp population. More detailed and expanded studies further upstream might indicate a sufficiently high carp population to warrant the eradication of all species and restocking with desirable species.

Within reach DD there are now several deep holes used extensively for fishing. This is a desirable condition and careful consideration of channel improvement by the engineer is recommended. Specific points include: Needed increased channel capacity be obtained by increased width, minimum change in present rock ledges in the channel that would reduce "fishing hole" depths, and that no modification of Upper Cataract Falls be included.

The use and mangement of sediment pools of the floodwater retarding structures offer opportunities for increased fish and wildlife habitat and population. Specific plans for this purpose can be considered as a part of the land treatment when requested by the landowner. Recommendations for developing the pool of structure No. 19 for attracting waterfowl have been prepared and are being considered locally. Greatly increased use of this approach should be encouraged to provide maximum benefit, use and improvement.

FORESTRY

The forestry phase of the watershed program was evaluated by the U. S. Forest Service. The procedure used in developing the data is described below. The forestry measures listed will contribute to watershed protection and flood prevention.

Procedure

Woodland areas for the watershed were entered on a U.S.G.S.map using 1958 aerial photos as a guide. Acreage of woodlands was obtained by using a dot grid directly on the aerial photos.

A cruise was designed establishing 29 study woodlands using random sampling techniques. One hundred and seventy-four measurements of hydrologic condition factors were made.

Timber types, conditions and volume were observed and determined for each plot. Past treatment and management needs were recorded. The data was summarized, analyzed and developed through standard calculations into the following program.

Preliminary participation estimates of forest land treatment measures which may be attained during the installation period were arrived at in consultation with the Service Forester and with the Work Unit Conservationists assisting the County Soil Conservation Districts. Final decision on measures and the amounts to be included in the work plan will eventually be determined in consultation with the watershed sponsoring organizations.

Woodland Condition Summary

The woodland acreage by counties is: Putnam - 7,400, Owen - 8,000, Hendricks - 1,300, and Morgan - 3,000.

Timber types are chiefly mixed hardwoods, although oaks and oak-hickory stands are common. Conifers are limited to a scattered few trees and those pines found in plantations. Several planted areas on farms in the tree farm program were noted.

Stocking	Acres	Percent
Well Stocked	6,700	34
Moderately Stocked	7,900	40
Poorly Stocked	5,100	26
	19,700	100

Merchantable Volume

Average Net MBF Per Acre	Acres	Percent
0-2	15,000	77
3-5	4,100	20
6+	600	3
	19,700	100

The average volume per acre is about 3,700 board feet. There are many poor stands not containing merchantable size material. Most markets are for saw timber with some outlets for posts, poles and white oak stave bolts. Pulp markets are very poor.

Cutting History (0-10 years past)	Acres	Percent
Little or None	15,700	80
Light	1,400	7
Moderate	600	3
Severe	2,000	10
	19,700	100

Grazing Damage (0-10 years past)		
None	10,600	54
Light	1,400	7
Moderate	3,600	18
Severe	4,100	21
	19,700	100

Although evidence of grazing was observed in nearly half of the woodland, the changing use of farmlands and better understanding of land needs have resulted in a reduction of livestock damage. Now less than 30% of the woodlands need protection. This will require concentrated efforts of all persons to achieve the desired level of protection.

No evidence of recent fires was observed. The watershed is in an area now receiving fire protection from the State under the Cooperative Fire Control Program.

Needed Forestry Program for Watershed Protection

The total need for each practice under the forestry program reflects the present condition of the woodlands. To achieve maximum improvement of the hydrology of the woodland soils, it would be necessary to accomplish the entire needed job. During the eight-year installation period a portion of this total need will be achieved. This eight-year goal is the immediate objective.

The total needs for forestry include:

Practice	Acres*	Percent of Total Woodland
Livestock Exclusion	5,500	29
Improved Forestry Practices	15,300	80
Sustained Yield Practices	4,500	23
Cultural Practices	9,200	48
Forestation	1,700	--

* Some areas need a combination of these practices while other areas need none. A total of this column shows total acres of needed treatments only.

Any one, or a combination, of these measures applied as needed will not only improve the hydrologic condition of the woodlands, but will result in improved land values and monetary returns from lands otherwise not paying their way.

The following list describes each of the standard practices as applied in the watershed projects:

1. Fire Control Intensification

This measure consists of prevention of woods fires, and effective control of any fire that may start. The forester would try to obtain State fire control protection to woodlands in the watershed. If intensive fire protection cannot be provided by the State, he should go through proper channels to alert the local volunteer fire department to provide the fire protection needed. The objective is to hold the burned area to zero acres but at worst to no more than 1/10 of 1 percent a year.

Some measures included would be construction of firebreaks, roads, and trails; lookout towers; installing firetool caches and training wardens and fire crews. Fire prevention education programs may also be needed.

Fire destroys litter and humus as well as the trees. Water infiltration, retention and detention are reduced and runoff is increased. Young growth is damaged or destroyed, and this adversely affects the development and replenishment of litter and humus. Productivity of the woodland in turn is decreased and the quality of products is reduced.

Technical assistance is needed for informing and demonstrating the benefits of fire protection and prevention measures to woodland owners. Assistance in locating personnel and equipment and in preparation of prevention materials may be required.

2. Livestock Exclusion

This measure consists of excluding all farm livestock permanently from woodlands. To accomplish this may require fencing all or a part of the woodland. It also may be accomplished by a permanant change in use of adjacent agricultural land.

Grazing by livestock has a damaging effect on the hydrologic condition of the woodlands. The litter and humus layers are destroyed or compacted which greatly reduces their ability to absorb water and to retain and detain it. As a consequence, the amount of runoff is increased. In addition, grazing destroys young growth and reduces the density of the stand and thus impairs the development and replenishment of litter and humus. Damage to the young growth and mature trees reduces the productivity of the woodlands and the quality of forest products.

Technical assistance is needed to inform and demonstrate to woodland owners the effects of woodland grazing from the standpoint of low forage yield for livestock and damage to woodlands resulting in poor hydrologic condition and reduced economic value.

3. Improved Forestry Practices

This measure, accomplished through proper management of woodlands, establishes a permanent forest cover adequately stocked with desirable species of suitable age classes.

In young stands a sustained yield management plan defines and schedules the improvement and protection measures needed to develop a thrifty fast growing woodland with good species. In woodlands having merchantable timber, proper harvesting of timber crops according to the best sustained yield practices will result in improvement and maintenance of an effective forest cover with good species composition, density, and age class conditions.

Use of proper logging methods and layout of roads in the woodlands with due regard to the topography and soil will help prevent harmful effects of the harvesting operation due to erosion and runoff.

These factors will assure maintenance and improvement of the hydrologic condition and of the productive capacity of the woodlands.

Technical assistance is needed for education and assistance in preparing woodland management plans, in marking trees to be harvested, utilization and marketing of products, and the proper logging methods.

The following measures; sustained yield practices and cultural practices, are a part of the total of this practice.

4. Sustained Yield Practices

This measure includes the preparation of timber harvesting plans including the marking, estimating and timber sale contract assistance. Help in locating logging roads, landings and portable mill sites to reduce soil and hydrologic condition damages and other activities in connection with the harvesting of woodlands are included.

5. Cultural practices

This practice consists of the conventional timber stand improvement measures and reinforcement planting with special emphasis on improving the hydrologic condition of the woodland. Diseased, defective, poorly formed and otherwise undesirable trees are eliminated from the stand by cutting, poisoning or girdling to improve species composition, stand density and rate of growth. At the same time it is important to maintain the proper level of stocking. This is accomplished with stand conversion or reinforcement planting.

Timber stand improvement will increase yields and produce higher quality products. It will help to insure that the land will remain in woodland, be managed and protected, thus contributing needed hydrologic benefits.

The stand conversion practices consist of planting trees in openings of thinly stocked woodlands to bring them to the proper stocking level and to improve their composition and hydrologic characteristics. A fully stocked stand of desirable tree species is the objectives.

Technical assistance is needed to determine the needs of various woodlands for treatment, type of treatment needed, and methods to be used as well as for demonstration purposes in marking trees which should be removed. Assistance in selecting tree species and planting methods would be included.

6. Forestation

This measure consists of planting suitable species of trees on open land for the establishment of a forest stand. Planting is recommended for land better suited to woodland than to agriculture, that is, land with steep topography, depleted fertility, presence of rock, brush, erosion, or other factors.

The purpose of the measure is to improve hydrologic condition by the establishment of a forest cover, and achieve better land use. This will build up litter and humus and create conditions which will contribute to better infiltration, retention and detention capacity, reduced runoff and soil stabilization.

Technical assistance is needed to help the landowner select areas to be planted and species and methods to be used in planting.

Planned Program for Watershed Protection

The following table shows need and expected participation and accomplishment during the 8-year installation period. These estimates presuppose that adequate technical assistance will be available to build and carry through an accelerated program and that a high level of cooperation will be shown by local groups and assisting agencies.

The following table attempts to separate the goals on a county basis as requested. It must be fully understood that the survey was not designed to provide this separation of data. For this reason, the figures for each county should not be considered as positive goals. They are provided, based on careful reasoning, for purposes of discussion and analysis by the watershed sponsors and cooperating technicians. The forester will be working toward the total goal and not toward the separate goals by counties.

Forestry Practices	County	(1) Needed Program (Acres)	(2) Estimated Participation (Percent)	(3) Planned Program (8 Years) (Acres)	(4) Est. Accomp. by Going Project (8 Years) (Acres)	(5) Balance for Watershed Project (8 Years) (Acres)
Livestock Exclusion L*	Putnam	1,300		640	320	320
	Morgan	2,000		800	80	720
	Owen	1,300		640	320	320
	Hendricks	900		320	40	280
	Total	5,500	44	2,400	760	1,640
Improved Forestry Practices M*	Putnam	6,000		2,000	200	1,800
	Morgan	2,400		1,500	150	1,350
	Owen	5,800		1,500	150	1,350
	Hendricks	1,100		800	80	720
	Total	15,300	32	4,800	480	4,320
Sustained Yield Practices H*	Putnam	1,500		400	30	370
	Morgan	750		200	30	170
	Owen	2,000		800	80	720
	Hendricks	250		100	10	90
	Total	4,500	33	1,500	150	1,350
Cultural Practices C*	Putnam	2,700		100	10	90
	Morgan	2,100		130	10	120
	Owen	2,600		140	15	125
	Hendricks	1,800		110	5	105
	Total	9,200	5	480	40	440
Forestation P*	Putnam	300		60	15	45
	Morgan	300		50	15	35
	Owen	100		50	5	45
	Hendricks	1,000		80	5	75
	Total	1,700	14	240	40	200

* Letter Designation Used in Tables

Column (1) total is based on needs as determined by field observations. Columns (2), (3), and (4) totals were determined through consultations with the SCS Work Unit Conservationist and Service Forester of the Division of Forestry and reflects their knowledge of what they can expect from the landowners in the watershed.

Column (5) total shows the accomplishment planned for the eight-year installation period by the accelerated PL-566 program.

Hydrologic Significance

The soils in this watershed are in Hydrologic Soil Group B, which is that group having average infiltration properties after presaturation.

The present hydrologic condition class is 2.7 with a corresponding runoff/precipitation curve No. 66. This is indicative of a poor hydrologic condition.

Installation of the measures programmed above will bring the average future hydrologic condition during the next 50 years to a class of 3.1 with a corresponding runoff/precipitation curve No. of 63. This is average or fair hydrologic condition.

REPORT OF THE U. S. FISH AND WILDLIFE SERVICE

This is our reconnaissance report on the proposed Mill Creek Watershed Project in Hendricks, Morgan, Putnam and Owen Counties, Indiana. This report has been prepared by authority of the Watershed Protection and Flood Prevention Act (68 Stat. 666), as amended. It has received the concurrence of the Indiana Department of Conservation as indicated in the attached copy of a letter of April 2, 1965, from Director John E. Mitchell.

Sponsors of the project are the Hendricks, Morgan, Putnam and Owen County Soil and Water Conservation Districts. The Mill Creek Conservancy District, now being organized, also will be a sponsor.

The Mill Creek Watershed is in west central Indiana. It has an area of about 187,136 acres (292.4 square miles). This total includes 7,300 acres of Federal land and 650 acres of State land. Mill Creek rises about 20 miles west of Indianapolis, flows southwest and enters Cagles Mill Reservoir.

Agriculture is the basic industry in the watershed. About 60 percent of the watershed is cropland; 18 percent, grassland; 11 percent, woodland; and the remaining 11 percent other uses or idle. General farming and livestock production are the major sources of agricultural income.

The Watershed Work Plan indicates that improvement measures will consist of 14 floodwater retarding structures, 53.31 miles of channel improvement, and appropriate land treatment.

Two of the floodwater retarding structures will be multiple-purpose, including recreation as a project purpose. Multiple-purpose structure No. 3 will be constructed on Vermilion Branch. It will have a surface area of 65 acres. Multiple-purpose structure No. 9 will be constructed on Crittenden Creek. Its surface area will be 140 acres.

Fishery resources vary greatly in different parts of the watershed. The lower reaches of Mill Creek, those extending from Cagles Mill Reservoir upstream for a distance of about 10 miles, have good populations of game fish. Portions of the stream here are unique in that the smallmouth bass, spotted bass and largemouth bass occur together. Upstream from the crossing of State Highway 42 in Putnam County, the main stem fishery becomes less important. This is due to reduced stream size and channel work done in past times. The tributaries of Mill Creek do not provide important fisheries.

The watershed has good populations of quail in most areas and high numbers in a few places. Pheasants are of little importance although few are found in the watershed. Rabbits and squirrels occur in fair to good numbers. Raccoons are plentiful along the lower reaches of Mill Creek and hunting them is a popular sport. Deer are found in light to medium numbers in the southern part of the area.

Our studies indicate that the proposed channeling activities will be detrimental to the fishery of Mill Creek. Straightening and enlargement of the channel in certain reaches will destroy or adversely affect stream habitat in the part of Mill Creek below Highway 42. Upstream from this road-crossing, channel excavation will produce effects which will also be damaging to the downstream fishery. Among these effects are the reduced productivity of bottomland animals and food plants and the increased turbidity of stream flows.

The two multiple-purpose impoundments will provide important fisheries in the watershed. One of these, structure No. 9, will be especially valuable if it is opened to public fishing.

Project effects on wildlife will vary. The proposed land treatment measures, generally, will be beneficial. On the other hand, there will be losses of habitat resulting from streambank clearing and from the establishment of permanent impoundments. Streambank clearing will be most damaging along the forested banks of Mill Creek in the lower parts of the watershed, where there is excellent habitat for raccoons, mink, and wood ducks. We are pleased to note, however, that selective clearing is planned in this area. Trees suitable for denning and nesting should not be removed.

It is recommended that:

1. Destruction of existing vegetation be avoided during construction of floodwater retarding structures.

2. Shrubbery and herbaceous borders be developed and maintained adjacent to impoundments, and that the Indiana Division of Fish and Game be consulted in the preparation of plans for these borders.

3. Impoundments be fenced to exclude livestock.

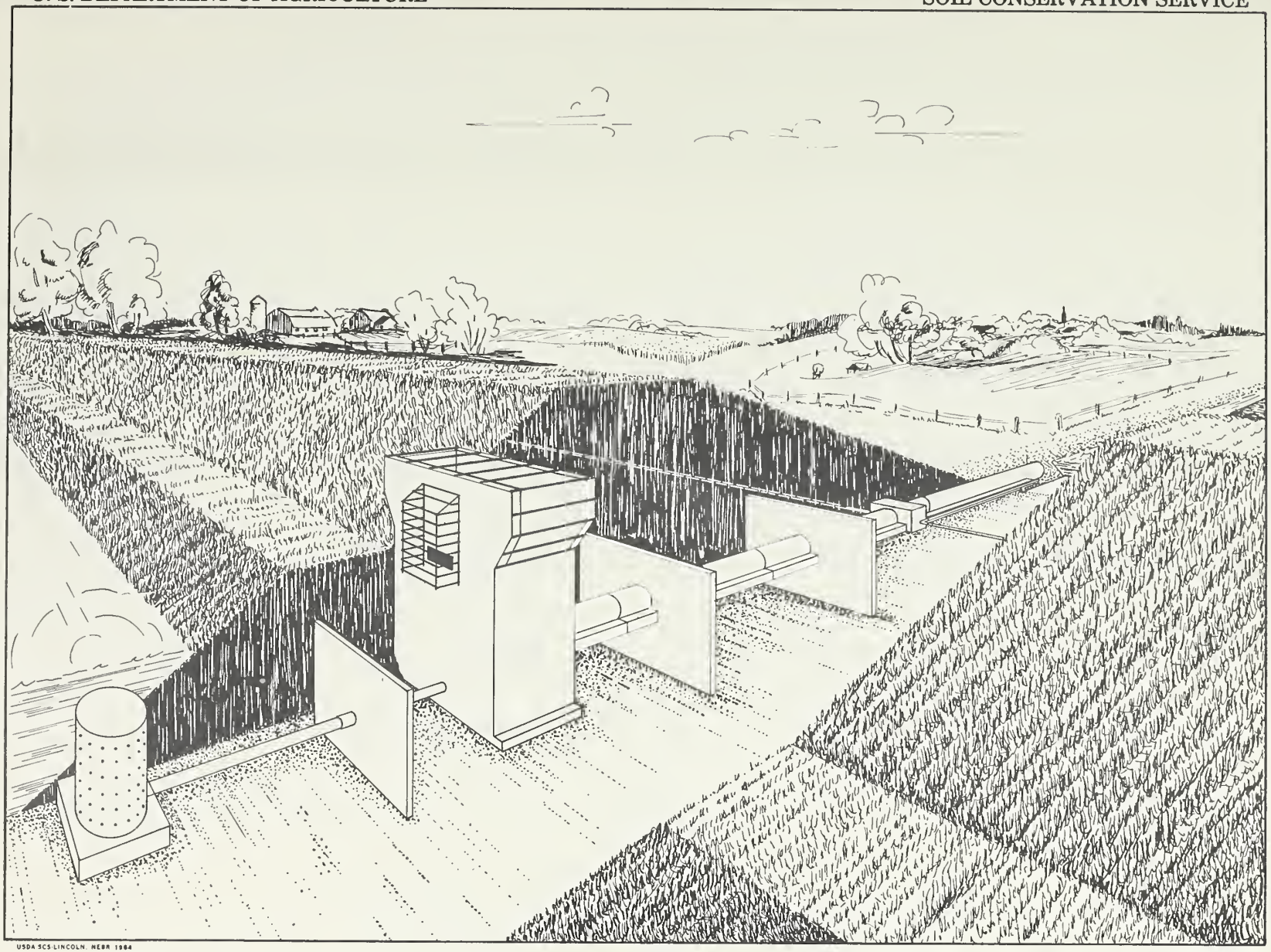
4. Channel excavation in the reach of Mill Creek below State Highway 42 be limited to lateral excavation, so that excavation be to no greater depth than the surface elevation of the stream under conditions of normal flow. This will permit the stream to return to its normal channel with the receding of floodwaters.

5. Streambank clearing be minimal along Mill Creek Downstream from Highway 42.

6. Eroded areas, wastelands, and borrow pits be reclaimed for wildlife through suitable plantings and land treatment.

Additional studies of this project by the Bureau of Sport Fisheries and Wildlife are not considered necessary unless there should be significant changes in project plans. We would appreciate being advised should such be the case.

The cooperation of you and your staff is appreciated.

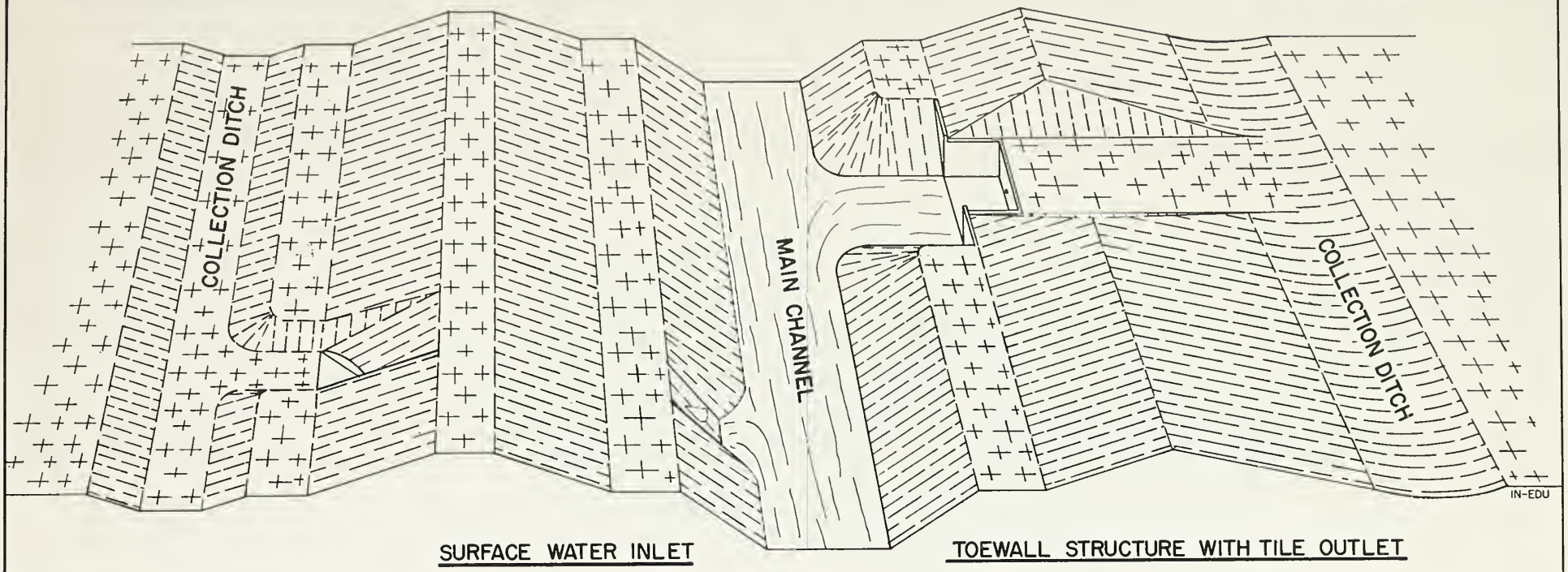


USDA SCS-LINCOLN, NEBR 1984

5, 0-20,698

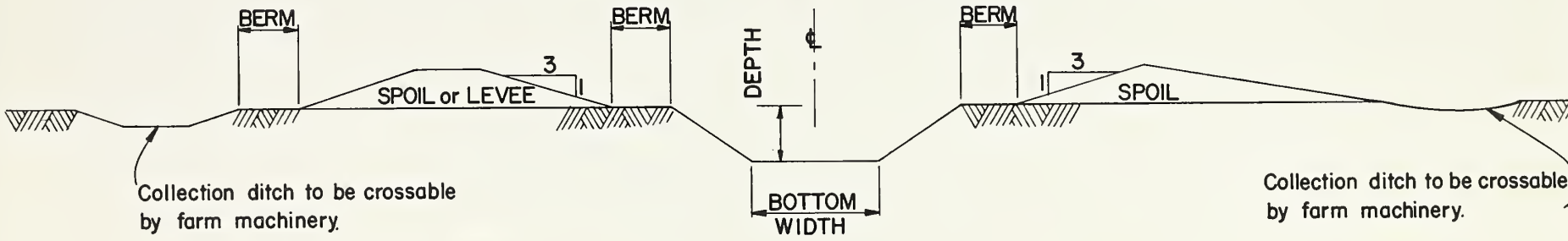
Reinforced concrete pipe drop inlet with drawdown

Figure 1



SURFACE WATER INLET

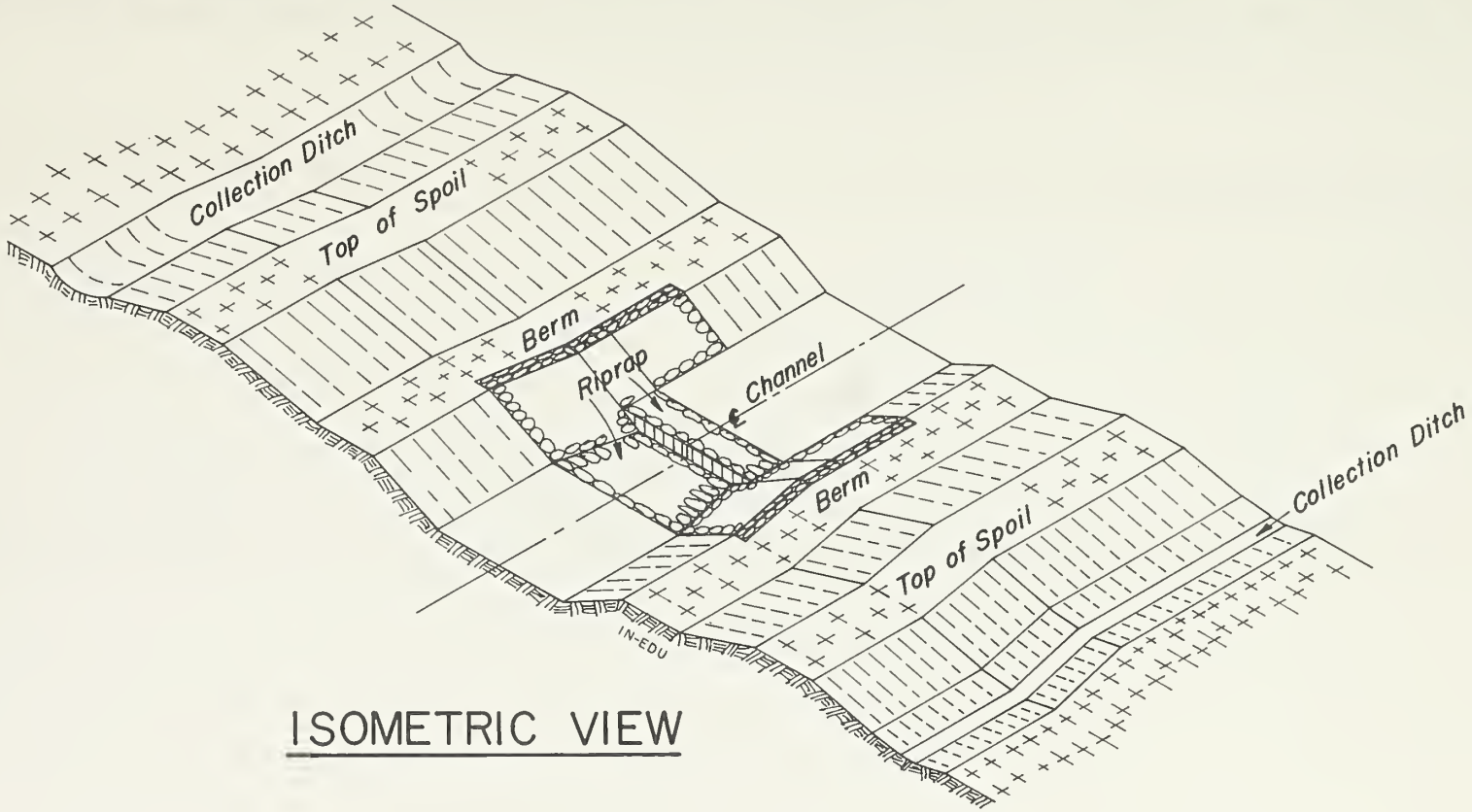
TOEWALL STRUCTURE WITH TILE OUTLET



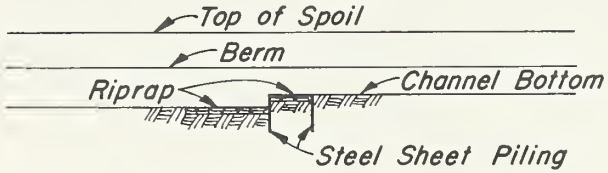
TYPICAL CHANNEL CROSS-SECTION

Figure 2

USDA-SCS-LINCOLN, NEBR. 1964



ISOMETRIC VIEW



SECTION ON CENTERLINE

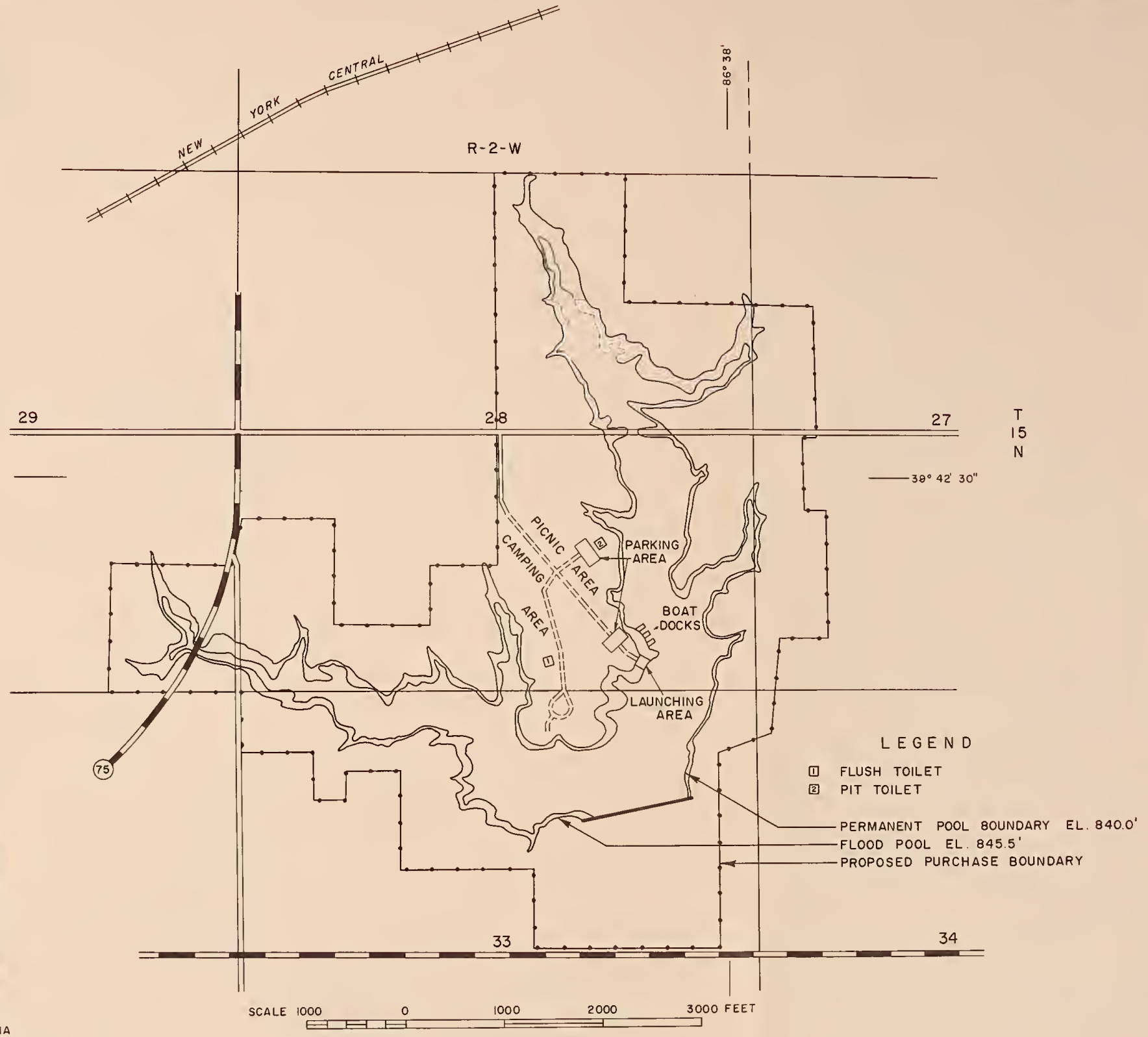
GRADE STABILIZATION SILL

Figure 3

USDA SCS-LINCOLN NEBR 1964

U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE



MILL CREEK WATERSHED

CRITTENDEN CREEK STRUCTURE No. 9

HENDRICKS COUNTY, INDIANA

SOURCE Prepared from Indiana USGS Quadrangle Coatsville

3,-15-65

5,P-21,239

USDA SCS-LINCOLN NEBR. 1965

US DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

PROJECT MAP

MILL CREEK WATERSHED

HENDRICKS, MORGAN, OWEN AND PUTNAM COUNTIES
INDIANA

LOCATION MAP

SOURCE: Prepared from drawing 3-S-46507 and detail furnished by Field Technicians

LEGEND

COUNTY LINE
CIVIL TOWNSHIP LINE
U. S. TOWNSHIP LINE
SECTION LINE
SECTION NUMBER 12
SUPER HIGHWAY
PAVED ROAD
GRAVEL ROAD
DIRT ROAD
RAILROAD, SINGLE
RAILROAD, MORE THAN ONE
CROSSING, GRADE
CROSSING, ROAD UNDER
CROSSING, ROAD OVER
BRIDGE, ROAD
SCHOOL
CHURCH
CEMETERY
CITY
PERENNIAL STREAM, SMALL
INTERMITTENT STREAM
STREAM DISAPPEARS ON FLAT
PERENNIAL LAKE OR POND
DAM, LARGE
PIPE LINE OR BURIED CABLE
POWER LINE
GRAVEL PIT, QUARRY OR MINE
WATERSHED BOUNDARY

FEDERAL LAND
STATE LAND
DRAINAGE AREA CONTROLLED BY STRUCTURE
AREA BENEFITED

DRAINAGE AREA IN ACRES — D A 5536 ac
DAMAGE REACH — B

PROJECT MEASURES

FLOODWATER RETARDING STRUCTURE
MULTIPLE-PURPOSE STRUCTURE
STRUCTURE NUMBER (2)
STREAM CHANNEL IMPROVEMENT FOR: FLOOD PREVENTION — 3-16-65 5,S-21,245

(20) D A 230 ac
(21) D A 150 ac
(22) D A 210 ac.

Scale in Miles 0 1 2 3 4

T 16 N T 15 N
T 15 N T 14 N
T 14 N T 13 N
T 13 N T 12 N
T 12 N T 11 N
R 5 W R 4 W
R 4 W R 3 W
R 3 W R 2 W
R 2 W R 1 W